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May 1948

TECHNOLOGY REVIEW

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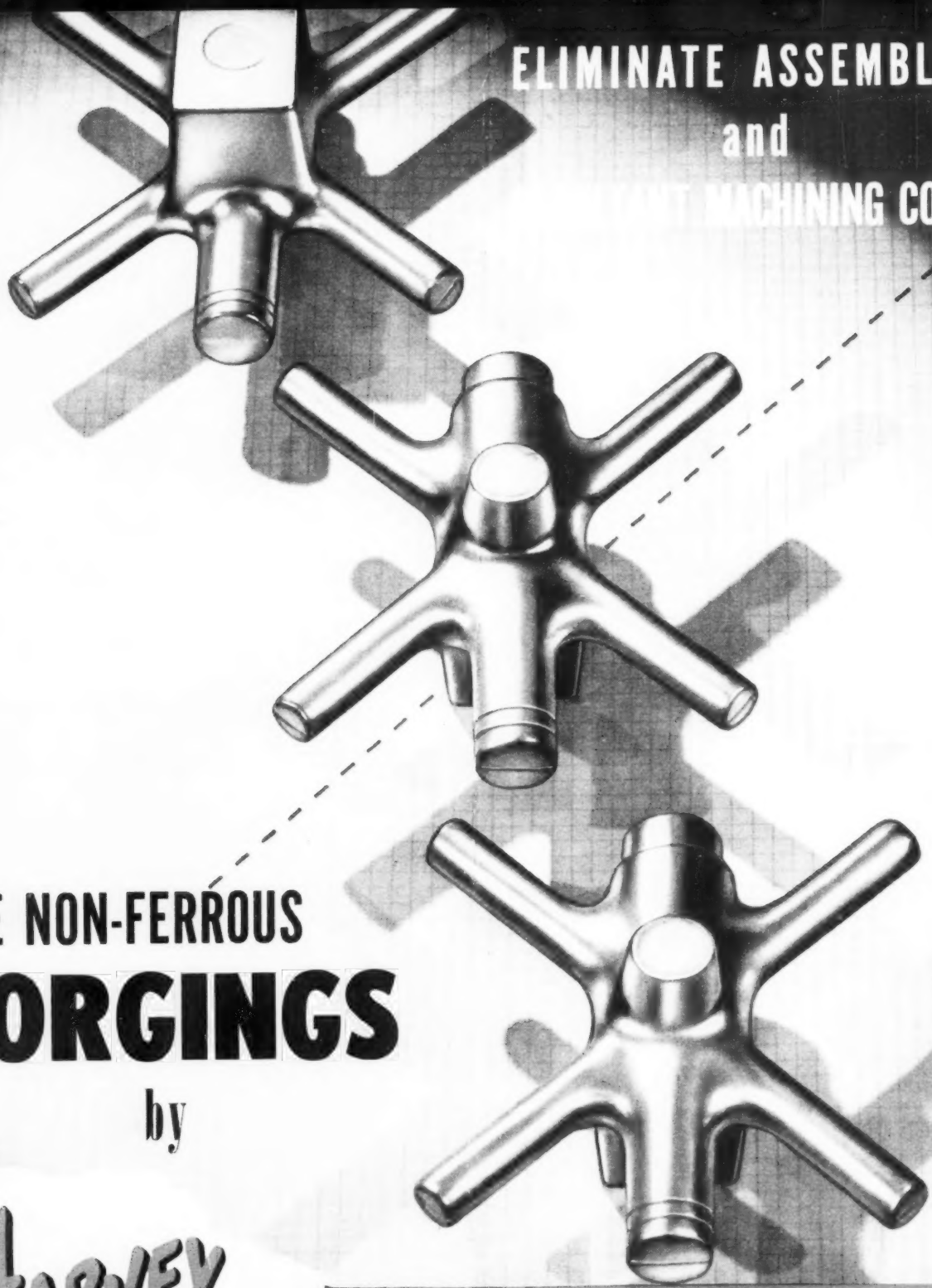

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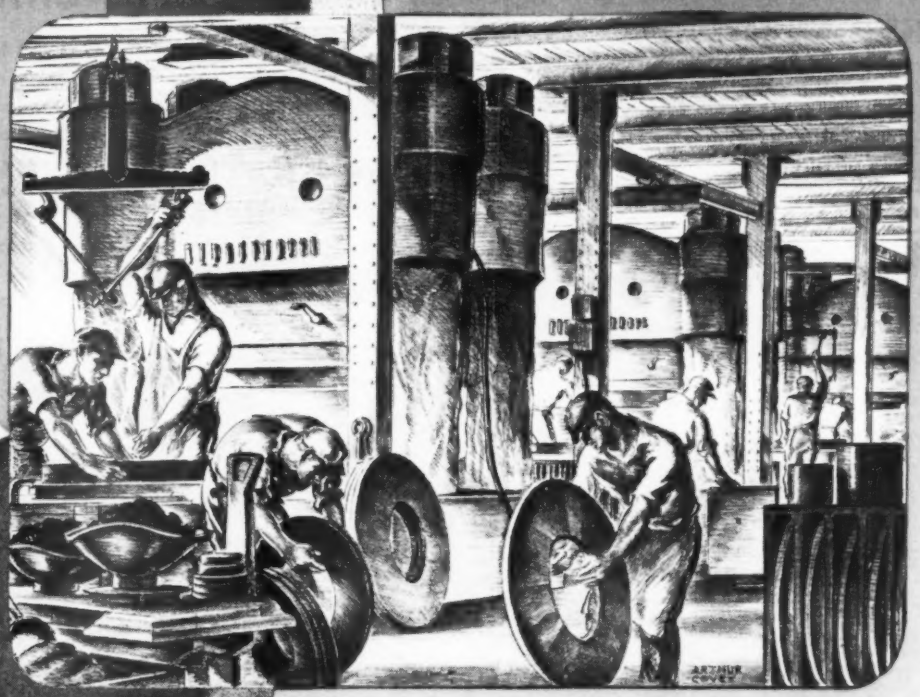

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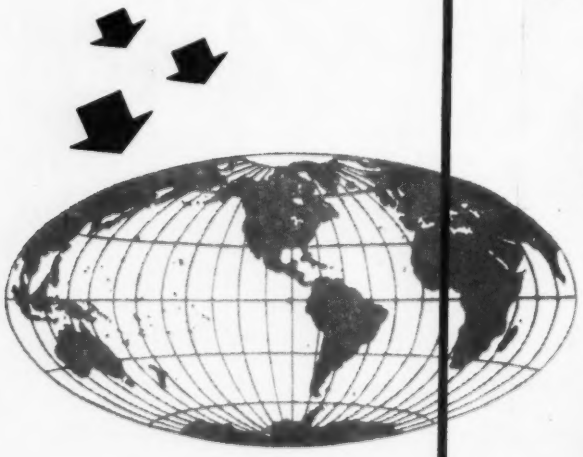

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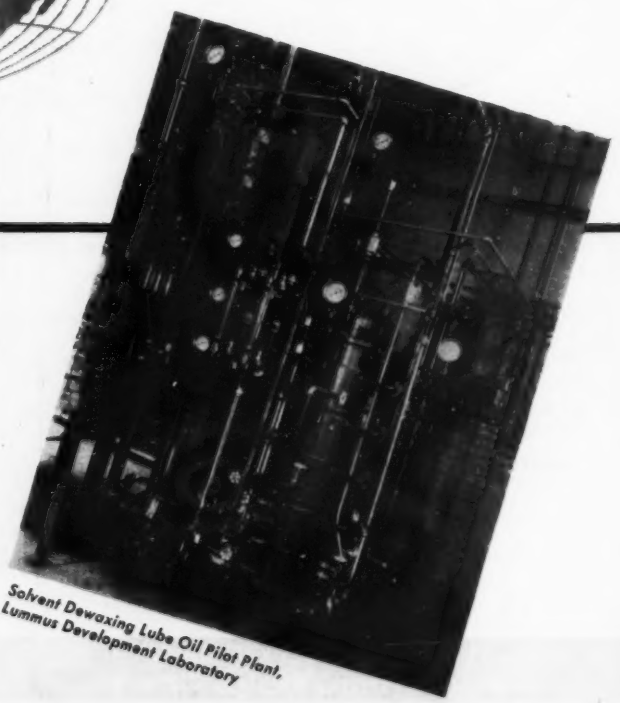
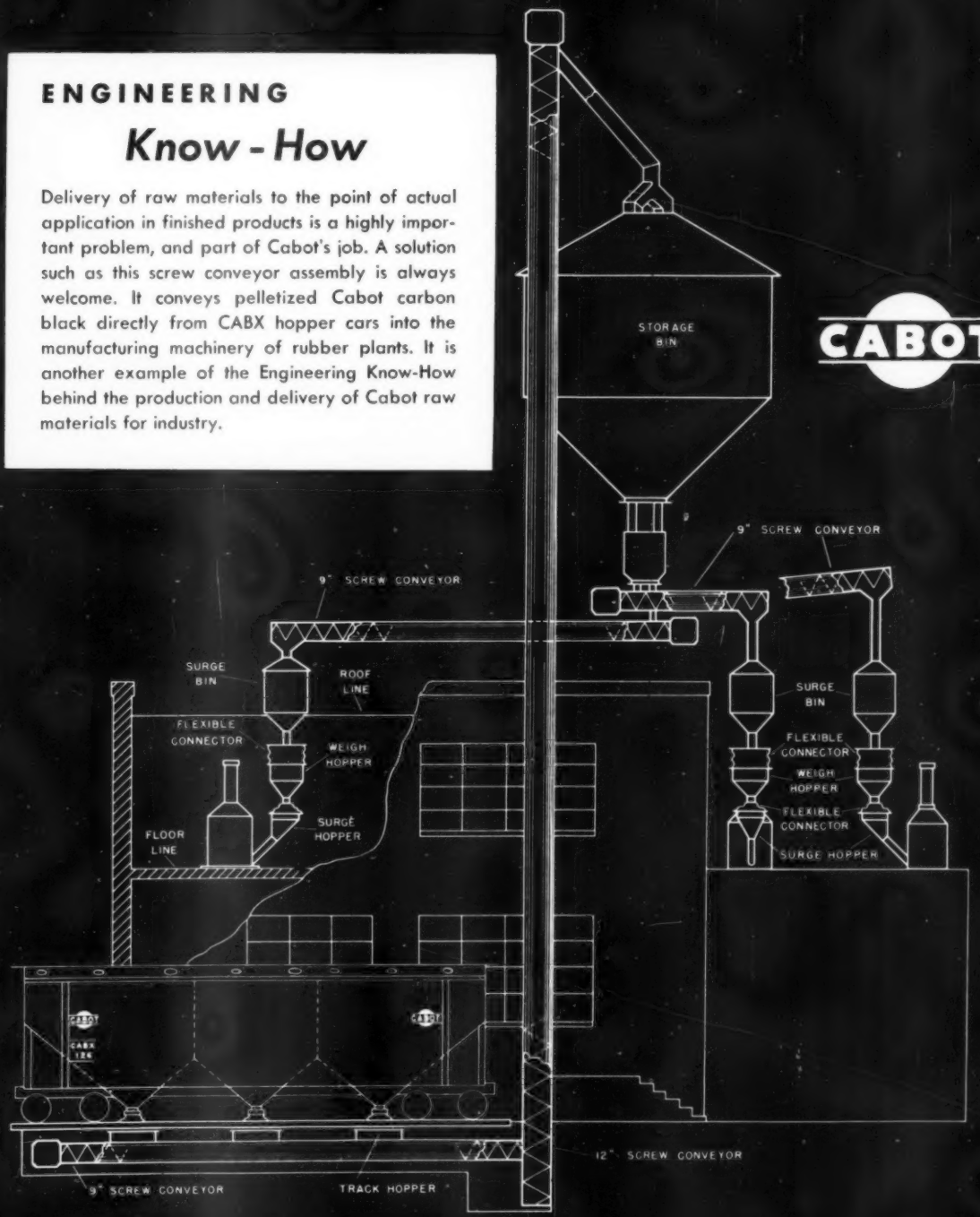


Solvent Dewaxing Lube Oil Pilot Plant, Lummus Development Laboratory

ENGINEERING

Know - How

Delivery of raw materials to the point of actual application in finished products is a highly important problem, and part of Cabot's job. A solution such as this screw conveyor assembly is always welcome. It conveys pelletized Cabot carbon black directly from CABX hopper cars into the manufacturing machinery of rubber plants. It is another example of the Engineering Know-How behind the production and delivery of Cabot raw materials for industry.



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Industries Served by TAFT-PEIRCE:

8: Clothing Industry

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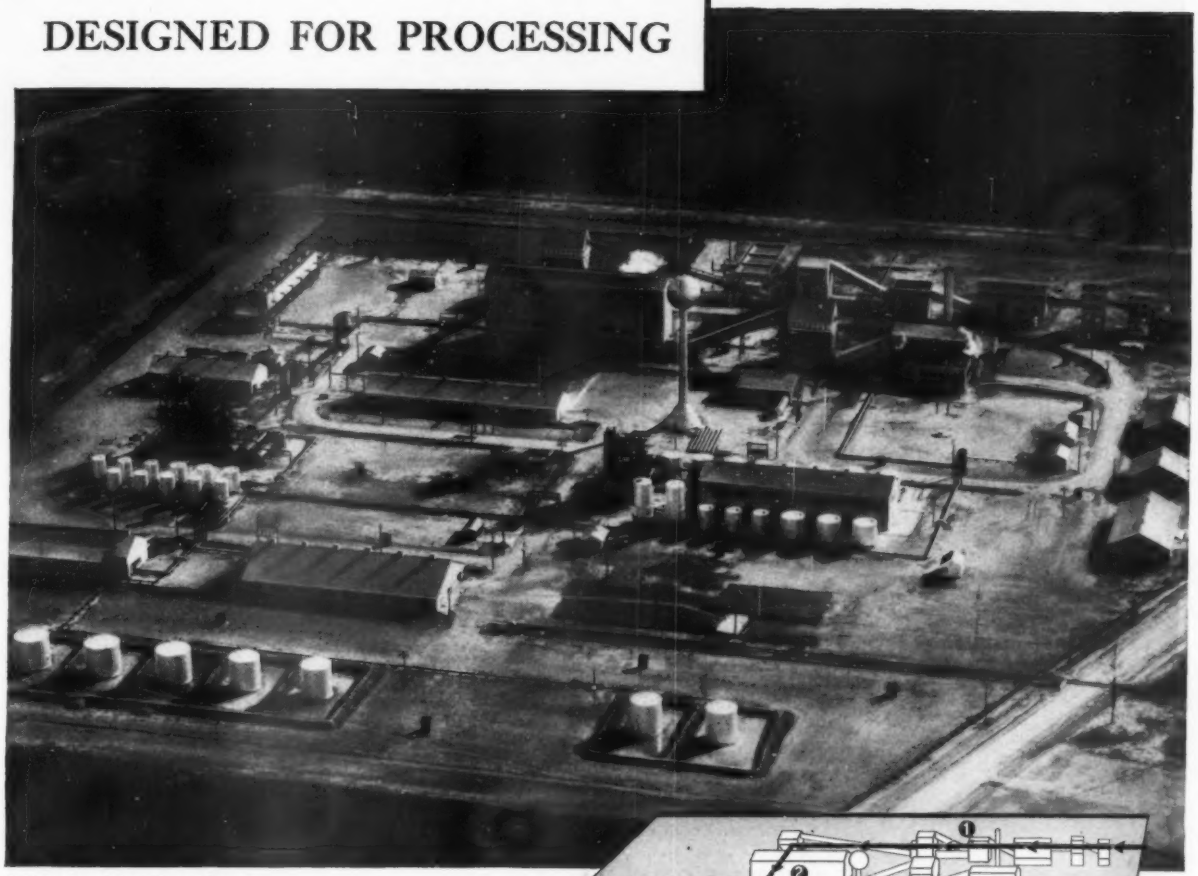

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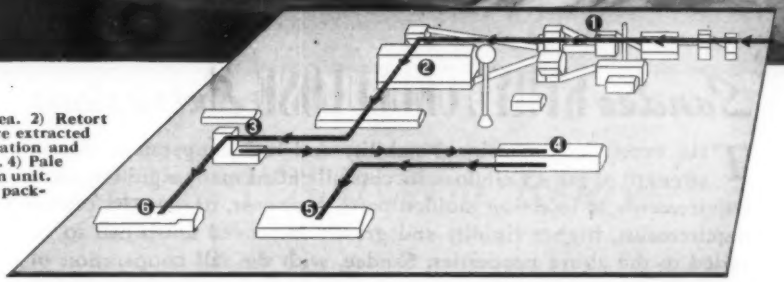

1) Wood preparation and grinding area. 2) Retort building where terpenes and rosins are extracted by solvent. 3) Finishing unit for distillation and separation of solvent, terpenes and rosins. 4) Pale rosin decolorization and solution evaporation unit. 5) Rosin packaging building. 6) Oil loading and packaging building.

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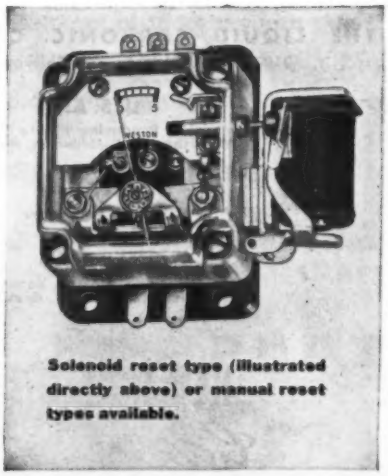

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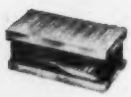
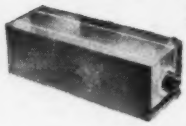


No. 408 Rectangular Model . . . has 4" x 8" working surface. Pole spacers closer than on other rectangular models, hold smaller pieces.



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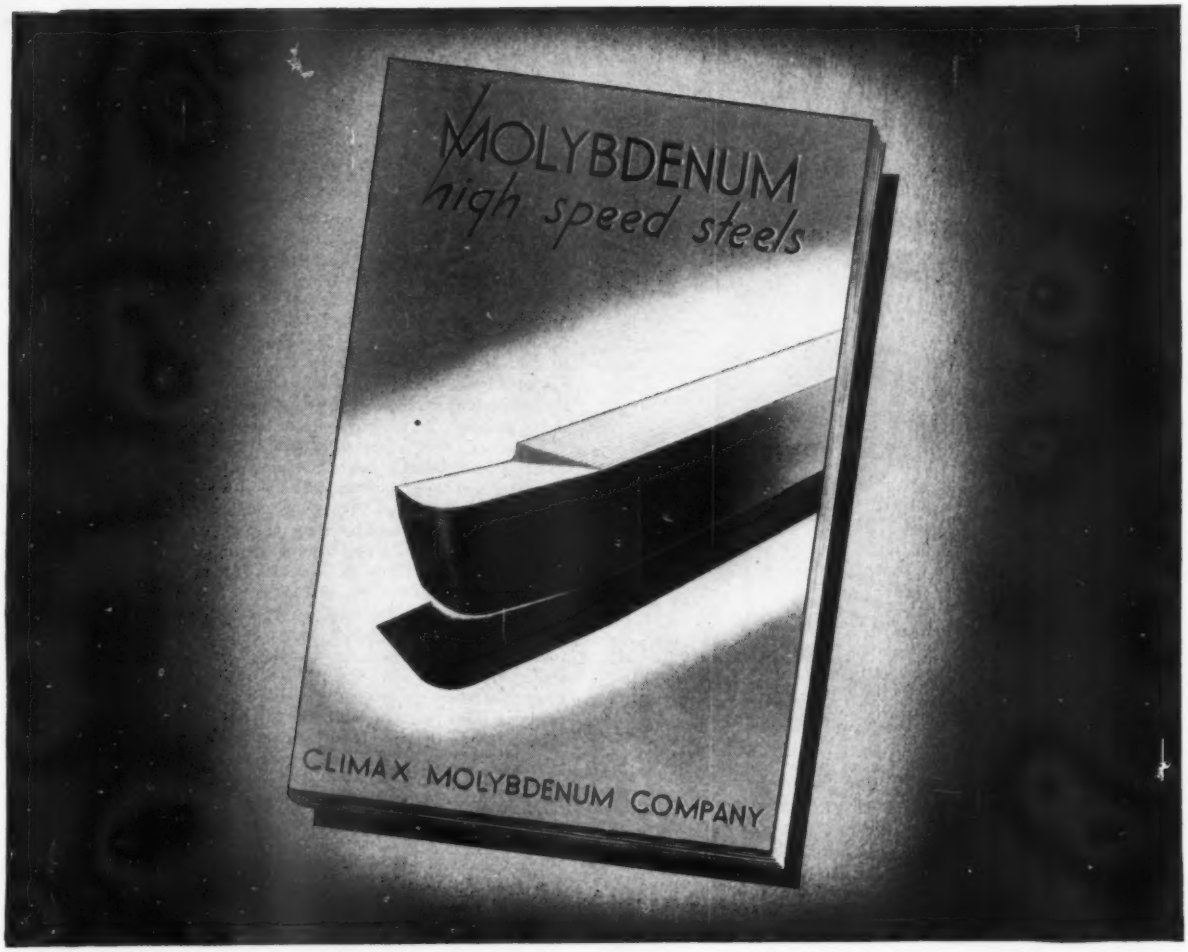
THE TABULAR VIEW

Egregious Upheaval. — Time was, not so long ago, when we looked forward in anticipation to the postwar period as the promised era of plastic homes, electronic hamburger ovens, and push-button gadgetry which would completely change our daily lives. But somewhere along the line in the past three years we were forced into a detour and now find that present-day realities are different — often quite different — from what had been expected. Probably nowhere is this statement more true than in the field of collegiate education where everyone is strenuously engaged in finding the way back to that tranquil leisure which is the best stimulant for creative advancement. The postwar adjustments now going on in the colleges and universities are comparable, in many ways, to the drastic changes which befell them in the years from 1941 to 1945, but the ultimate effects of the new conversion are likely to be more permanent. In his article "M.I.T. Redeploys for Peace" (page 371), JAMES R. KILLIAN, JR., '26, sets forth the Institute's responsibilities in the training of young men and women for the modern world of technology, and outlines a program, already in progress, for enhancing the Institute's service. Not alone in physical plant facilities, but in the caliber of its Faculty, staff, and curricula as well, is M.I.T. scheduled to embark on a new era.

Three's a Crowd. — Within recent months, newspaper stories have reported new attempts by several persons to solve the age-old problem of Greek geometers; that of trisecting any given angle through the use of a compass and straight edge alone. Perhaps such news presages the rise of a new crop of "angle trisectors" for WILLY LEY recalls (page 375) that solutions to this problem come to public notice with the periodic regularity of the 17-year locusts. But whether we are to be deluged with the layman's discoveries or not, Mr. Ley's article states the problem of the ancient Greeks clearly and, in so doing, aims to put mathematician and angle trisector on the common ground of speaking the same language. Readers will also find a number of methods for dividing an angle into three approximately equal angles. Mr. Ley, an editorial associate of The Review, is a research worker at the Washington Institute of Technology.

Blow Hot; Blow Cold. — Bodily comfort depends on where you are — and what you're wearing. How important the latter aspect is was found out, on a large scale, by the United States Army who went to great lengths to develop suitable textiles for use in the armed services. The conflicting textile requirements, and the methods which fabric designers used to overcome natural limitations, are described (page 378) by STANLEY BACKER, '41, and NORMAN E. ROBERTS. During World War II, Mr. Backer served as research officer at the Philadelphia Quartermaster Depot. Upon his release from active duty as a captain in 1946, he returned to the Institute and received his master of science degree in 1948. Mr. Roberts is a graduate (1942) of the C. M. Price School of Journalism. During the war, he was engaged in historical work at the Philadelphia Quartermaster Depot.



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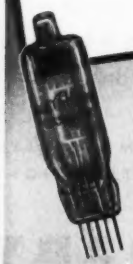

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MAIL RETURNS

Fueling the Railroads

FROM L. J. FITZ GIBBON, '35:

Some time ago I was perusing the March, 1947, issue of The Review and read with considerable interest the article "Liquid Diet for the Iron Horse" which appeared on page 269. I feel that the issue involved was too lightly treated and the conclusion drawn too erroneous to go unchallenged. I decided to query several of my better informed friends in the railroad fraternity to learn their opinion and to obtain some pertinent facts. Therefore, the following facts are offered in rebuttal to the above mentioned article:

Considerable Diesel-electric locomotive expansion has been done through default of the steam-locomotive builders and others responsible, in the industry, for product improvement and advances in design.

In the early 1930's there were more than 40,000 steam locomotives on American railroads, the major number of which were obsolete by modern standards and the majority of which were coal-burning. The steam locomotive, for all practical purposes, monopolized the field of railroad transportation. The coal industry, at that time, sold more coal to the railroads than it did to any other single industry.

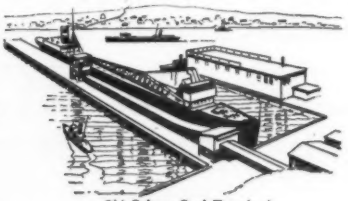
At the time of the advent of the first railroad Diesel-electric locomotive (early 1930's) the coal industry had no interest in fuel economy on locomotives, nor was it much interested in supplying anything but the poorer grades of fuel. It was common practice to use the railroads as outlets for a large volume of low-quality, bituminous coal that could not be sold elsewhere. Often the railroads were practically compelled to accept low-grade coal in order to keep mines along these roads in operation. In fact, the railroads' purchases of locomotive fuel was often the difference between profit and loss for the mine operators.

A number of studies of Diesel *versus* steam have been made but the facts are obscure and the results have been misleading. In only a few exceptional instances have railroads tried to produce a better steam locomotive: in these few instances the results have been excellent. But no major railroad, until quite recently, has taken advantage of ways and means available to make steam locomotives perform better. The coal industry, even today, is only half heartedly co-operating.

There is no doubt that in some instances Diesel power is highly suitable for certain transportation jobs and is preferable to steam. But there now seem to be very good reasons for believing that the purchase of Diesel power at very high first cost, and the cost of maintenance on certain railroads, make this type of power unattractive from the "cost of transportation" angle. Railroads which have had Diesels in service for upwards of 10 years are faced with rapidly rising costs for upkeep and are now looking with favor on other forms of power.

(*Continued on page 408*)

Speed with Economy



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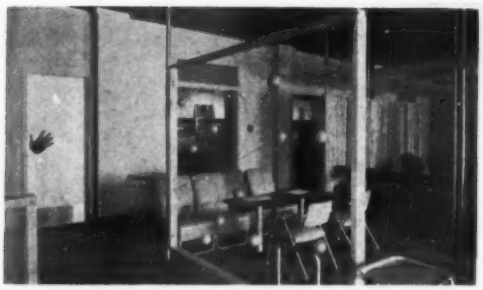

THE TECHNOLOGY REVIEW

TITLE REGISTERED, U. S. PATENT OFFICE

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

☆ ☆ ☆

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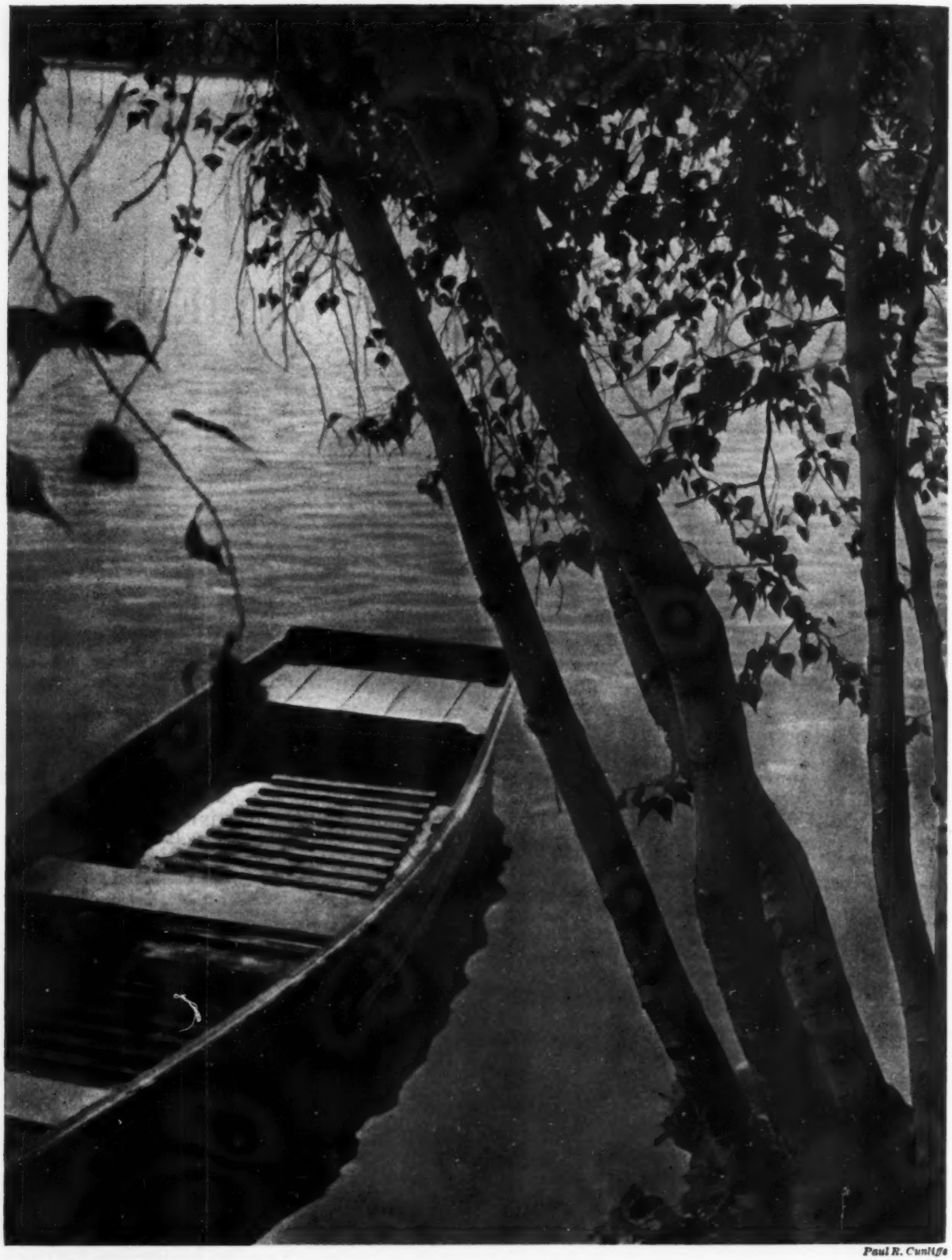
Published monthly from November to July inclusive on the twenty-seventh of the month preceding the date of issue, at 50 cents a copy. Annual subscription, $3.50; Canadian and foreign subscription, $4.00. Published for the Alumni Association of the M.I.T.: Raymond H. Blanchard, President; H. E. Lobdell, Executive Vice-president; C. George Dandrow, John A. Lunn, Vice-presidents; Charles E Locke, Secretary; Ralph T. Jope, Treasurer. Published at the Rumford Press, 10 Ferry Street, Concord, N. H. Editorial Office, Room 7-263, Massachusetts Institute of Technology, Cambridge 39, Mass. Entered as second-class mail matter at the post office at Concord, N. H. Copyright, 1948, by the Alumni Association of the Massachusetts Institute of Technology. Three weeks must be allowed to effect changes of address, for which both old and new addresses should be given.



Paul R. Cunliffe

Invitation to Spring Fever

THE
TECHNOLOGY
REVIEW

Vol. 50, No. 7 May, 1948

The Trend of Affairs

Obiter Dicta *on Man Power*

DEMAND for man power has increased 25 per cent in the past eight months, whereas man power in search of work has decreased 20 per cent in the same period. As a result, the man-power shortage is greater now than it has ever been. Such, at least, are the conclusions to be drawn from a study of recent activities of the M.I.T. Alumni Placement Bureau which has widespread contacts with industry and also with highly trained technical and administrative personnel.

Several causes appear to be at work to account for this latest demand for qualified personnel. For one thing, the government has re-entered the field more aggressively than ever and is bidding with industry for a wide variety of technically trained persons. Many organizations, going into fields which are new to them, lack suitably trained men on their staffs to supervise new undertakings or sell new products. In other cases, companies are issuing personnel requests which are admittedly "impossible" but they refuse to consider anyone who doesn't meet the standards which they have established. There is also evidence to indicate that even some of the largest and presumably best organized corporations did not believe that business would continue to boom, for otherwise the mature and well-trained young veterans, hired in the fall and winter of 1945, would now be ready to fill vacancies in supervision which plague companies the most. Finally, it should be recognized that some companies have developed a practice of "shopping around" to determine whether man power would be available if needed; therefore, many jobs which are listed do not represent actual vacancies. It is interesting to observe that the real or fancied demand for technically trained man power has caused a number of engineering and scientific societies to inaugurate employment contact services within the last year.

Under such conditions of a seller's market, it would appear that there should be no supply of personnel from which to draw. For a number of reasons, however, there is a small reserve. Many who graduated between 1943 and 1947 are growing bored on their training jobs and seek a change. Even those in engineering groups say supervision is so poor that they work hard one week and then spend the next two dull weeks trying to appear occupied. The housing shortage accounts for other manpower availabilities, since it compels a man who must seek a new job to exhaust every possibility within commuting distance of his home.

Apparently companies are getting along by overworking the older, tired, and still underpaid engineers on their staffs and promising them the "perfect man" as an assistant "as soon as they can find him." In the meantime, the vast numbers of young men who have been hired are growing restless because they lack adequate supervision and their capabilities are not used to the full.

If the government's swing into renewed activity in research and development carries on into production, as it seems likely to do, the older, more mature men will be in demand once more. Already there are signs that there will be considerable displacement and enforced job changing among recent graduates now employed in consumer goods manufacture.

In the meantime, the average or slightly better than average man who is over 45 is once more in trouble when he seeks a new position to compare in salary and responsibility with what he has had. Indeed, the most distressing tendency that shows up is industry's abrupt postwar rejection of the older man. Each organization has its own excuses for this, but company insurance rules are blamed more frequently than seems reasonable. When a man who has reached 40 is refused employment for a position of responsibility "because such men have lost their flexibility and have become set in their ways," it is time to look at the company's management to see whether it has not lost its flexibility and dreads being stirred out of its rut by the injection of new blood, sufficiently mature and experienced to meet management at its own level.

Hot Water?

AT BEST, only a handful of the most articulate and energetic readers — and certainly no editor — is ever likely to muster a sufficient array of facts to dispel a widely held view that editorial meat must be sandwiched between the bread slices of advertising for the latter to achieve its maximum effectiveness. Yet, withal, commercial copy does stand very definitely on its own feet — or so we maintain. Indeed, the revenue-producing copy is, not infrequently, more interesting than the editorial grist in the adjacent column, with which it vies.

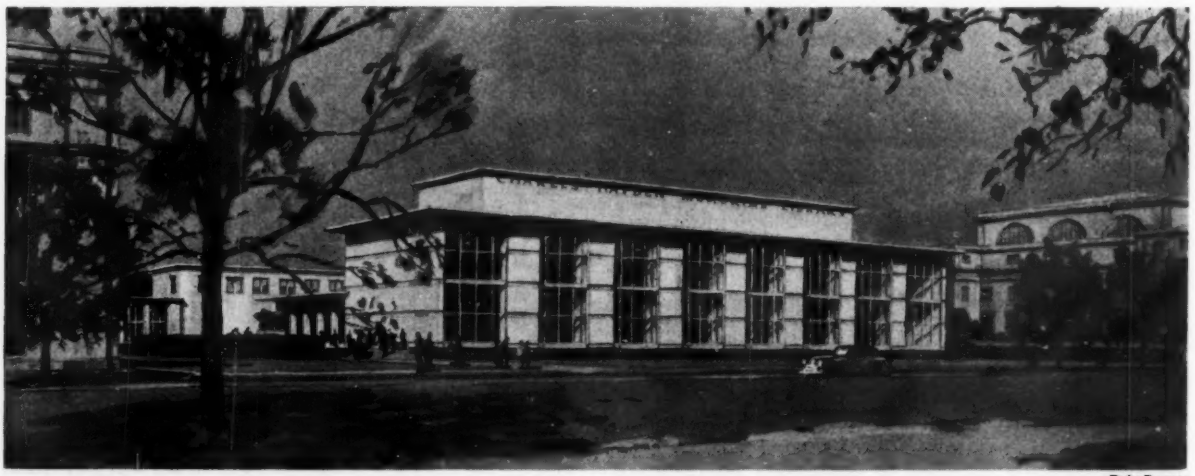
In substantiation of this thesis, we reproduce text from an advertisement which caught our eye in a musty volume of bygone days when, it would appear, publishers enthusiastically inserted folios hawking their wares for pages on which one would expect to find an index. Thus, in *Practical Electricity and Galvanism* by John Cuthbertson, published in London in 1807, two years before Lincoln was born, we find the reader's attention invited to a pamphlet on "Directions for Learning to Swim; by attending to which a Person, who has never been in the Water, may escape being drowned" by Benjamin Franklin, LL.D.

The pithy epigrams of *Poor Richard's Almanack* were widely quoted in our young nation when Cuthbertson's volume appeared, and Franklin's lightning rod and electric kite experiments were respected internationally. So also were his musical glasses and his discovery that Paris was illuminated by a huge natural source in the morning when many a Parisian was still abed. Possibly the spirit of the times forbade open recognition of the international reputation of a colonist, especially in the mother country. At any event, publisher J. Callow apparently felt that Franklin's work would benefit by the burnish of popular acclaim, for in the announcement he included what is evidently a portion of a book review. In a lily-guilding eulogy the reviewer, a Dr. Currie, says: "The authority of the American Bacon is of great weight in Medicine, as in every other branch of Science, that he touches, and particularly in what respects immersion in water; for doubtless he spent more time in this element than any philosopher of modern days."

Colloidal Antibiotics

UNTIL NOW, more than 20 germicidals, known as antibiotic substances, have been discovered, but only four of these have proved to be of any value from a medical point of view. Of these, penicillin is the most important not only from the standpoint of having saved thousands of lives but also because it has stimulated intensive research in the general field of antibiotics. Since penicillin was discovered by Fleming and his co-workers in England, a tremendous amount of data pertaining to its applicability has been collected. Very little, if any, information has been obtained regarding its mode of action, however, probably because penicillin is a most evasive and elusive substance.

Until quite recently, most emphasis in all research pertaining to penicillin and its production has been placed on a purely chemical approach. Now Professor Ernst A. Hauser, at the Institute, and his co-workers, Dr. John W. Phillips and Mrs. Ruth G. Phillips, have discovered that solutions of penicillin are not true solutions at all but must be classified as colloidal sols, which are dispersions of many fine particles in a liquid. The new property has been ascertained by systematic ultramicroscopic studies. It has also been verified by the fact that penicillin sols exhibit the very pronounced reduction in surface tension which is typical of colloids, such as soap, which have the property of concentrating in the surface layer of the solution. Penicillin sols must be classified as colloidal electrolytes, for their behavior is similar to that of soaps which have the tendency to adsorb on, or coat, solid matter with which they are brought into contact. Although preliminary bacteriological tests have already shown that the colloidal properties of a penicillin sol possess more than a casual relationship to its effectiveness, no definite answer can yet be offered for its mode of action. It has also been found that the particles of a penicillin sol carry an electric charge, as do other colloidal sols, and such charge may have a direct bearing on bacterial growth. The significance of this finding appears to merit attention, particularly in the medical field, for it has been ascertained that bacteria also may carry an electric charge. (*Continued on page 402*)



Drix Duryea

Architects' rendering of the Charles Hayden Memorial Library at M.I.T., the construction of which was begun on April 5. The building, which is expected to set a new standard in library design, will occupy a site between the main educational buildings of the Institute (left) and Walker Memorial (right), facing the Charles River Basin. It is anticipated that the new library will be ready for occupancy in the fall of 1949.

M.I.T. Redeploys for Peace

Strengthened by an Outstanding Record of War Service, the Institute Advances Its Educational Program as Its Major Peacetime Responsibility

By James R. Killian, Jr.

THE American scholar, to a degree without precedent, became a wandering scholar during World War II. Not only were he and his fellows distributed and redistributed geographically over the face of the earth; they were redistributed in function to a degree without precedent both in civilian and in military capacities.

Never isolated, even in peace, behind an ivory curtain, the M.I.T. staff in World War II became involved and redistributed to a greater extent than that of almost any other American institution. As a result, the M.I.T. staff was more completely diverted from education, although the Institute was actually enlarged as a war research organization. The concentration of war research on its campus, the presence here of a great assemblage of gifted scientists from hundreds of institutions, and the remarkably varied activities of its own staff, in Cambridge and elsewhere, all contributed in one overshadowing way to the establishment of a fresh and vigorous postwar program. No one at M.I.T. during this postwar period can fail to be impressed by the ferment of ideas, the prevailing temper to re-evaluate and to strike out in new directions, and the broadened concept of the Institute's responsibilities which is a direct outgrowth of the wholesale cross-fertilization that has resulted from the Institute's war program. The expanded commerce of thought resulting from these conditions is probably the most profound aftereffect which the war had on M.I.T.

Another effect of these special conditions was M.I.T.'s rapid war demobilization and its equally rapid mobilization for peace. The organization which had functioned to oversee $100,000,000 of war research was geared to liquidate the war program expeditiously and at the same time to rebuild the long-term educational program. Those who served on the Institute's governing bodies during this period will long remember the excitement and urgency of reconversion. They will remember how a housing program for married veterans — the first in an American college — was planned and started before Federal funds became available. They will remember the improvisations to handle the tidal wave of applicants and how the limited classroom space was painstakingly utilized to the utmost to accommodate more than 3,000 students beyond the number registered at war's end. They will remember the search for new talent in the war-research laboratories, which, with the generous support of the Corporation, quickly brought to M.I.T. a remarkable group of outstanding graduate students and a number of major and eminent Faculty appointments. In rapid succession new programs were adopted, as in food technology, in economics, in the humanities, in electronics, and in nuclear science; departments were rebuilt and given new direction, as in the School of Architecture and Planning; new facilities were blueprinted and financing started, as exemplified by the Gas Turbine Laboratory, the Research Laboratory of Electronics, the great Charles Hayden Memorial Library, and the Senior House.

While the staff was thus throwing its released energy into rebuilding the educational and research program, steady progress was being made in demobilizing the war-research organizations and in readapting buildings and equipment in a manner that could best serve the interest of the country and leave the Institute in as strong a position as possible for its expanded peacetime program. Both the temporary and permanent buildings erected for war work have been acquired by the Institute. This added space has not only enabled us to take care of the great increase in the student body but at the same time has both permitted and required a wholesale reallocation of space and renovation of equipment throughout the entire Institute plant. This general redistribution of space — the greatest since the Institute moved from Boston to Cambridge — together with the acquirement of new buildings, has required an expenditure of $1,750,000. While this has been a very severe drain on the Institute's limited unrestricted funds, the Corporation felt the expenditure was warranted by the resulting gain in educational efficiency.

Adjustment to Expanded Enrollment

The great rush of redeployment after the end of World War II soon came face to face with an overwhelming enrollment of students in numbers greater than the Institute had ever handled before. Prior to the end of the war, two decisions had been reached: (1) M.I.T. would readmit all former students who had obtained leave for war service, and (2) M.I.T. had an obligation to accept a substantial temporary overload of students in order to share, to the limit of its ability and educational standards, in the national policy of providing educational opportunities for veterans. The result of these two decisions quickly became apparent, to an unexpected degree. Former students returned in larger numbers and more quickly than had been expected. Nearly 95 per cent decided to return to the Institute and in the fall of 1946, when but 700 had been expected, a total of 1,100 actually registered. In the meantime, applications were pouring in from veterans at a rate of about 4,000 a month for nine months and the tapering off has been at an astonishingly low rate. As a result the Institute found itself with 5,660 students in the

N.B. This article is reprinted from Chapter 20 of the forthcoming book *Q.E.D. — M.I.T. in World War II* by John Burchard, to be published in May by The Technology Press (Cambridge), and John Wiley and Sons (New York).

No one at M.I.T. during this postwar period can fail to be impressed by the ferment of ideas, the prevailing temper to re-evaluate and to strike out in new directions, and the broadened concept of the Institute's responsibilities which is a direct growth of the whole cross-fertilization that has resulted from the Institute's war program.

fall term of 1947, to make a total 80 per cent greater than the largest prewar enrollment. The resultant load on staff and facilities has not been proportional to the increase in the number of students. It has been far greater since nearly every subject of study has had to be given every term, three terms a year. As a consequence the load on the staff has been excessive judged by any ideal long-range program. This becomes all the more apparent when it is remembered that, in addition to this large teaching commitment, the Institute's staff has the responsibility for directing a great research program, which in dollar expenditure will total more than $10,000,000 in 1947–1948, nearly 20 times larger than any comparable program undertaken before World War II.

It is interesting to note that the number of people at M.I.T. during the 1946–1947 period totaled more than 8,000 or as many as during the peak of the war. Whereas during the war there were 2,000 students and 6,000 staff and nonstaff personnel, now there are more than 3,000 personnel and 5,660 students. Before the war approximately 1,500 people were employed, which is less than half of the present total.

Program for a New Era

The budget for 1947–1948 of nearly $16,000,000 is more than four times the largest prewar budget. Of course the enlargement of our program and the overload which these statistics reflect have had a bearing on the Institute's reconversion. Under prevailing conditions there could be no return to prewar organization or leisure. Under the postwar conditions the Institute has come hard upon vitally important adjustments to insure its effectiveness as an educational institution.

Foremost among all our responsibilities is that of maintaining a strong educational program. In the wake of war's disruption, it has been necessary to retest programs, regain standards, and look ahead. Is our curriculum the best that we can devise to meet the conditions of the postwar world? What are the optimum conditions for creative scholarship and research on the part of both students and staff? These basic questions are being examined by all the groups responsible for the management and conduct of the Institute, and significantly enough the current overload is not precluding this basic rethinking of our program.

The Faculty, for example, has appointed a Committee on Educational Survey to make a long-range study and re-evaluation of our curriculum and those policies which contribute to educational effectiveness. Under the chairmanship of Professor Warren K. Lewis, '05,* this committee has taken its assignment in great seriousness and has initiated a deeply probing study of those factors which contribute toward making an educational institution vigorous in scholarship and spirit. Not only is it reconsidering our undergraduate curriculum in the light of our prewar objectives but it is reaching out to determine what the objectives of the future should be in the training of scientists and engineers. Under the impetus provided by Dean Robert G. Caldwell's repointing of our humanities program, it is giving special attention to the problem of how best to relate the humanities to a professional curriculum and what kinds of training will best equip an engineer to handle the great social and public responsibility and power which must inevitably rest in his hands. And finally it is courageous enough to tackle some of the imponderables, mentioned above, which affect the "wanderings, alightings, fertilisings of man's thought." † What are those factors which we must emphasize at M.I.T. to provide the best possible environment for scholarly, creative work by our students as well as by our staff?

* Other members of the committee are: Professors John R. Loofbourow, Ronald H. Robnett, C. Richard Soderberg, '20, and Julius A. Stratton, '23.

† "The Commerce of Thought," a lecture by Sir Arthur Quiller-Couch.

Concurrently with the study by the Committee on Educational Survey, other approaches to the problem are being followed. Under the leadership of Dean John W. M. Bunker, the Committee on the Graduate School has underwritten the high standards of graduate study here while at the same time providing greater flexibility to the individual student in pursuing his professional objectives. New ways of organizing and co-ordinating research with teaching are being tested and policies are formulated for handling sponsored research to the advantage of the academic program. During World War II we observed the effectiveness of research teams, and we are now experimenting to determine how best to reap the advantages of group research in an academic organization. We are certain that research teams should never displace the brilliant individualist who avoids entangling alliances, but we want to find out how the two approaches supplement and assist each other.

One of the devices which we are using to handle group research — and to stimulate individual work — is what we call centers of research. These are interdepartmental organizations which co-ordinate the co-operative activities of various departments in important fields of overlapping interests. While we call them centers of research because research is their predominant role, they are nevertheless playing a very important part in our educational program, especially by providing superior opportunities for senior- and graduate-student thesis work.

As the postwar program develops, other educational trends are clearly observable. There has been a fresh and constructive concern with teaching methods, and several departments have instituted carefully designed programs for checking and improving the instructional techniques of young staff members. Reflecting the current interest of students in educational methods, one of the student honorary societies has undertaken careful evaluation of individual instructors in selected departments, all with the wholehearted interest of the departments.

In another direction, there is a trend, continuing from before the war, toward deepening engineering education through the adoption of more of the analytical tools of pure science, through more graduate training in engineering, and through the use of research to attract men of imaginative minds and to educate engineers who have the temerity and capacity to dream and speculate beyond the boundaries of the immediately practical. Similarly the science departments have deepened their programs, and the push (which began in earnest in 1930) to build a great School of Science, occupying a position of equal partnership with the School of Engineering, has brought science into full partnership.

Along with the deepening and broadening which come from a comprehensive understanding of physical laws, there is the broadening effect of humanistic study, which is receiving increased attention, as already noted in connection with the Committee on Educational Survey. Concurrently with the study by this committee, other approaches to the problem are being followed. The humanistic effects of extracurricular activities and the close integration of our humanities with supporting activities in the Technology community are being explored. In this direction, Everett Moore Baker, who was appointed dean of students on January 1, 1947, and Thomas P. Pitré, who became dean of freshmen at the same time, are exerting a powerful and liberalizing influence on the student body, with a response from the students of instant and hearty appreciation. The registration officers in all of the several professional courses have stepped up their own effective contacts with students, and other personnel have thrown themselves into the over-all movement to bring students and staff into a community of scholars having the broadest possible outlook.

Contributing importantly and by design to this community building has been the new Director of the Medical Department, Dr. Dana L. Farnsworth, the Institute's first full-time medical director. Out of a background of both psychiatry and internal medicine, he has made the Medical Department an important and liberalizing factor in safeguarding the health and promoting the morale of students and staff. To serve the general welfare of the students in close relation to the Office of the Dean of Students and the Medical Department, a full-time director of athletics has been engaged and charged with the responsibility of making athletics serve education in the broadest sense.

Students at M.I.T. exhibit a similar interest in improving the environment and broadening the base of education at the Institute. With veterans returned from service comprising 60 per cent of the student body, we of course have an older and more mature group, but we also have a new interest in the values to be found in the field of the liberal arts. The present-day student usually has a well-thought-out program for his education and a willingness to work without stint to get ahead rapidly. Without any diminishment of his interest in professional subjects, he is willing to organize a liberal arts club; to organize a symphony orchestra; to sponsor (and to attend) lectures by prominent figures from nonprofessional fields; and to run carefully planned forums on such subjects as labor relations and universal military training.

Postwar Units and Personnel

Concomitantly with this broadening of interests of the staff and students has been a broadening of the Institute's planning for its future development. Instead of expecting that the major portion of the Institute will be east of Massachusetts Avenue, we now realize that the growth of M.I.T.'s educational facilities is certain to be so great that these facilities alone will require all of the land on the eastern half of the campus. The western tract of 50 acres is now conceived of as an area where we may develop really adequate student housing and recreational facilities and where a new type of campus development might be carried out which would have the dignity, beauty, and community living facilities that would contribute to the development of well-rounded men. In this area will be located the new Senior House, the Institute's first dormitory unit designed on the house plan and already under construction. Here, too, we hope to have other housing units, adequate playing fields, and a gymnasium so long needed and still unrealized.

The planning of facilities to promote a broadened education is epitomized in the concept for the Institute's Charles Hayden Memorial Library now being built.

The Charles Hayden Memorial Library is but one unit in the Institute's present program planned to implement the developments and new objectives. In addition to the library and west campus already mentioned, this program, ultimately involving a total expenditure of $28,000,000, includes development of such new educational

facilities as a Metals Processing Laboratory,* a Hydrodynamics Laboratory and Naval Towing Tank, a Supersonic Wind Tunnel, now under construction, and a Gas Turbine Laboratory, already completed, and permanent buildings for the Research Laboratory of Electronics, the Laboratory for Nuclear Science and Engineering, and a Laboratory for Biology and Food Technology. In addition there are essential facilities for enriching student life, including the new gymnasium and the new Senior House, already mentioned, and, in behalf of the staff, a Faculty Club. The launching of this development program and the solicitation of funds to carry it through have been major undertakings of the redeployment period. Of the total of $29,000,000, the equivalent of about $9,000,000 has been secured, but the remaining $20,000,000 must be raised. Actually the needs of M.I.T. are greatly in excess of this total, and the next five years must witness a sustained effort to enlarge capital resources of the Institute.

Is Our Staff the Best Possible?

This record would be incomplete without an estimate of the effects of World War II on the Institute staff and of the personnel changes made during the redeployment period. Before the war the Institute possessed a staff of magnificent capacity and scope. What is the situation today?

By any available test, the Institute has gained strength. Fortunately there were few losses; almost 100 per cent of the senior professors who were on leave are back. This was a major factor in the Institute's successful reconversion. While getting back its war service personnel, the Institute had an exceptional opportunity, as a result of its expanding program, to make a large number of major new appointments and to set high standards of selection in making these appointments. The war contacts of staff and administrative officers and the concentration in Cambridge of a great number of outstanding men during the war were major factors in assisting the Institute to spot men who met these high standards. In every major appointment we sought to answer affirmatively the question: Is the candidate the best available man in the country or even in the world to fill the post? Essentially the same question has also been asked in making promotions to the full professorship.

As a sampling, let me list some of the new appointments, omitting many outstanding younger members of the staff and limiting the list to those who now rank as full professors or who occupy positions of administrative responsibility.

Edward L. Moreland, '07, who withdrew from the deanship of engineering to become executive vice-president, part time, has been succeeded as dean of engineering by Professor Thomas K. Sherwood, '24, of the Department of Chemical Engineering. To the deanship of the School of Architecture and Planning has come William W. Wurster who had been in private practice in California. To the Office of Dean of Students has come Everett Moore Baker, a minister from Cleveland. A new post has been created, carrying the title of director of libraries, and this has been filled by John E. Burchard, '23, Director of the Bemis Foundation. To replace William N. Seaver, who retired for age, Vernon D. Tate of the National Archives has become librarian. Dr. Dana L. Farnsworth has become medical director.

Among recent appointments to department headships are Arthur C. Cope, who came from Columbia to head the Department of Chemistry; William T. Martin, who came from Syracuse University and is now head of the Department of Mathematics; Vice-admiral Edward L. Cochrane, '20, who comes from the Navy Department, where he has been chief of the Bureau of Ships and more recently chief of the Material Division, to head the Department of Naval Architecture and Marine Engineering; and William L. Campbell, '15, who came from industry to head the Department of Food Technology. From our own staff came C. Richard Soderberg, '20, to head the Department of Mechanical Engineering, John B. Wilbur, '26, to head the Department of Civil and Sanitary Engineering, and John Chipman to head the Department of Metallurgy.

Julius A. Stratton, '23, of the Department of Physics was appointed head of the Research Laboratory of Electronics, and Jerrold R. (*Concluded on page 404*)

* Announced in the April, 1948, Review.

Is our basic curriculum the best that we can devise to meet conditions of the postwar world? What are the optimum conditions for creative scholarship and research on the part of both students and staff? These basic questions are being examined by all groups responsible for the management and conduct of the Institute.

Some Angles on Trisection

Angle Trisectors Never Solve the Ancient Greek Problem of Dividing Any Given Angle into Three Equal Parts but Sometimes They Evolve New Approximations

By Willy Ley

ALTHOUGH no connection with sunspot or any other cycle has been established so far, a rash of angle trisectors arises every 15 years or so. Even though it may not be classed as a disease in the strict medical sense, such periodic outcropping of misguided energy takes on many of the characteristics of a recurring epidemic. We appear to be reaching the peak of one such epidemic at the present time and, in the interests of public health, it is instructive to examine and recognize the symptoms even though science knows of no sure and effective way of blighting the plague of angle trisection.

A patient's symptoms are easily detected. An angle trisector suffers under the hallucination that a given angle can be divided into three equal parts, using only a compass and straight edge. Furthermore, he has decided that he is the man to do it, although he knows that the problem is more than 2,000 years old. Presumably the hoary age of the problem is all the more reason to find a solution and be done with it forever.

When such a rash of trisectors does break out, there is usually also a mathematician around who tries to point out that angle trisection, in the sense in which the term was used by ancient Greek geometers, simply cannot be done. Usually, his attempts are not too successful because the repercussions evoked by the trisectors, while fortunately restricted to a comparatively small group, are loud enough to prevent him from getting more than about three words in edgewise. Here is the second easily recognized symptom.

The third symptom appears when the trisector submits a drawing something like that in Fig. 1 to a competent mathematician or preferably to a reporter, editor, or other individual in a position to bestow publicity. The drawing is accompanied by a letter, the text of which runs something like this: "Hah! So one can't divide an angle into three equal parts, eh? How's this for an angle? The angle has 90 degrees because it is a right angle. An equilateral triangle with one side coincident with one side of the right angle is constructed and it has three angles each of 60 degrees. Then I bisect one of these angles to divide the right angle into three equal angles of 30 degrees each. It took me only four hours to figure this one out — and the mathematicians themselves admit that they have tried to do that for the last 2,000 years!"

The mathematician who is expected to substantiate the discovery of the ages has little recourse but silence and decides that apparently he does not speak English well enough to be understood, even though he always thought he did. Wasn't the problem to trisect "any given angle"? Of course he knows that an angle of an integer number of degrees can be trisected provided that the number of degrees is divisible by nine. But he also thought that everybody knew he knew it. The end of the battle is invariably a stalemate. Three dozen people still believe that they can trisect angles. Four thousand others agree with them. The mathematicians are able to offer proof of the impossibility of solving the Greeks' problem of angle trisection but they are seldom, if ever, able to convince the angle trisectors of the ills to which they are heir.

The misunderstandings always arise because the two combatants do not have the same thing in mind. When the mathematician says that angles cannot be trisected he means that there is no way of doing it with absolute mathematical correctness for any given angle, using only a compass and a straight edge — the latter of which is to be employed only for connecting two points, and not for measuring distances. The case of angles with an integral number of degrees divisible by nine (such as 9 degrees, 18 degrees, 27 degrees, and so on) is excluded from that statement, since the methods applicable for such angles do not apply for "any given angle."

What the mathematician does not mean is that any angle cannot be trisected with considerable accuracy for

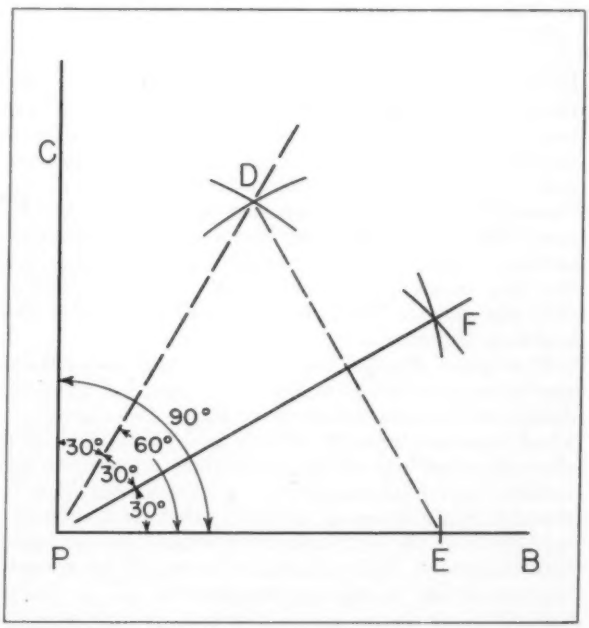


Fig. 1 — Any angle having an integral number of degrees which is divisible by nine can be accurately trisected. This diagram shows a simple method for trisecting a right angle by constructing an equilateral triangle with one side along the edge of the angle to be trisected, and then bisecting the resulting 60-degree angle at the apex.

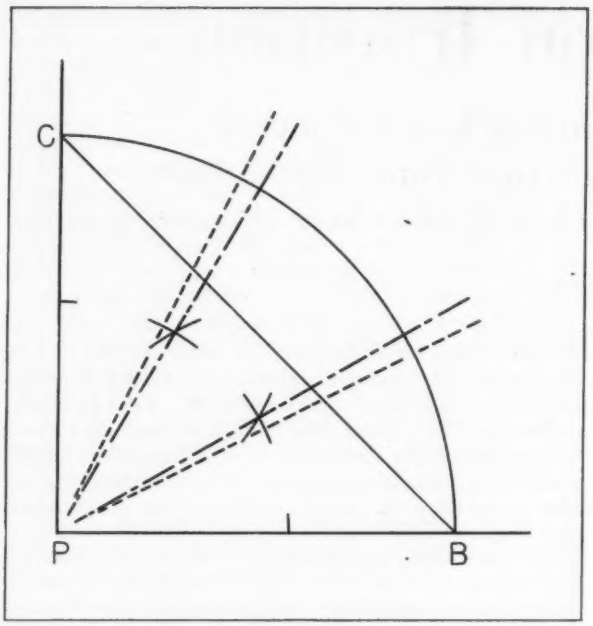


Fig. 2 — A common error into which "angle trisectors" fall is failure to distinguish between trisecting an angle and trisecting a straight line. The trisection of a straight line, connecting two points equidistant from the apex, divides the given angle into three parts (dotted lines) which are usually but poor approximations to the true angle trisection, as shown by the dot and dash lines in the diagram. The approximation becomes closer as the original angle becomes more acute.

all practical purposes. Of course that can be done; otherwise, there would be no dividing heads for milling machines, no cogwheels with an uneven number of teeth, no protractors or sextants, and not even instrument dials or clock faces.

But the trisectors rarely listen to explanations. In fact, they often overlook the main point of the argument and believe that the problem is not to divide an angle into three parts, but to divide a straight line into three equal parts.* The group that jumps into the problem without thinking about it usually draws an angle, sticks the point of a pair of compasses into its vertex, lays off equal distances on both legs, and connects them with a straight line. Then they usually invent a highly complicated method — there is a very simple one — for trisecting that line precisely and connect the points of division with the vertex. That, they believe, has divided the angle into three parts.

Well, yes, it has, but not into three equal parts. What goes wrong can best be explained by doing just that and doing it with an angle that can be trisected. A right angle which has been properly trisected (dot-dash line) and also "trisected" by dividing into three equal parts the straight line, CB, connecting its legs (dotted line) is shown in Fig. 2. It can be seen easily that the middle section (between the dotted lines) is larger than the other two. Naturally, if the trisection is applied to a small acute angle the error is not conspicuous.

* As is done here for a matter of convenience, angle trisectors often limit their attention to the trisection of acute angles for which reasonably accurate approximations can be made. The errors in practical methods of trisecting angles become more apparent as the angle is made greater than 90 degrees.

The next group begins by thinking about the problem. Their reasoning is this: if I have an angle, BPC (Fig. 3), and halve it in order to obtain its bisector, PQ, and then draw two lines parallel to that center line, DO and D_1O_1, these two lines must somewhere intersect the lines trisecting the angle. There is not the slightest doubt in anybody's mind that this reasoning is correct. At one point, the two lines will trisect the arc, and with it the angle, precisely.

The "fly in the ointment" is that this particular point cannot be determined except for some exceptional angles, such as those of an integer number of degrees if their integer can be divided by nine. But the trisector has a simple scheme in mind. He has two parallel lines, marked DO and D_1O_1 in Fig. 3. Now he draws one line, D_2R, parallel to the one leg of the angle, and then another one, D_3R, parallel to the other leg. Their distances from the legs of the angle are the same as the distance of the first pair of parallel lines from each other, that is, $C_1D_2 = D_2D_3 = D_3B_1$. From this construction it appears that lines from P through D_2 and D_3 would trisect the angle, CPB, neatly. The proof seems plausible until we remember that it was the arc, CB, which had to be trisected, whereas the construction has made the chords equal. For practical purposes, however, this method will do if angle, CPB, is sufficiently small. If, in addition, the drawing is done very carefully, it is possible to reduce the error to less than the thickness of the lines involved. Such approximation does not satisfy the mathematician, but it is acceptable to the engineer.

The last rash of trisecting mania seems to have occurred in Germany in about 1930 and while it did not add anything to the theoretical knowledge of the mathe-

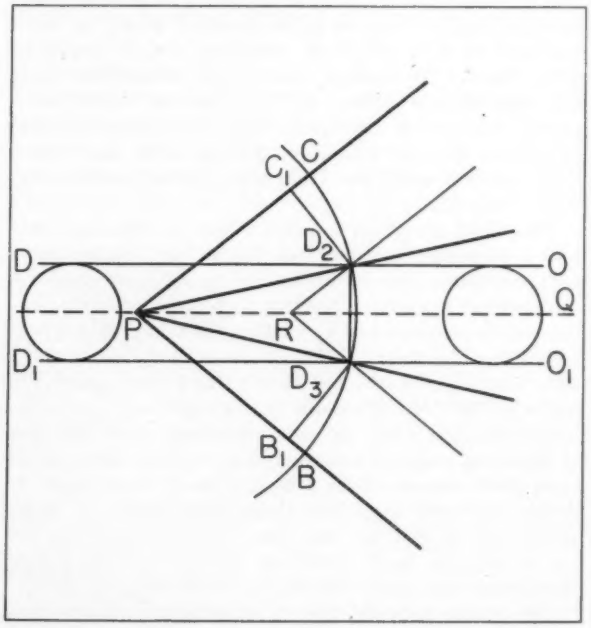


Fig. 3 — A recurring trick for "trisecting" angle BPC is to draw equidistant parallel lines to each leg of the angle to be trisected. Parallel lines of the same spacing are also drawn symmetrically about the bisecting angle. The intersection of the parallel construction lines determines the points, D_3 and D_2, which, if connected with the vertex, P, yield angles which trisect BPC. The resulting approximation is not very precise but is useful for trisecting small angles.

maticians, it did produce two very interesting methods of approximation which can be carried to any desired accuracy — except what is called mathematical accuracy.

One of these approximations is shown in Fig. 4 in which the angle, CPB, is to be trisected. In the construction the arc, CDEB, lays off equal distances on both legs, PB = PC, and a straight line connects points B and C. Then an arbitrary number of straight lines is drawn from the vertex, P, through arc, CDEB, dividing the angle, BPC, into several sections, not necessarily equal. Each of these radial lines will pass across the spherical segment between the straight line, BC, and the arc, BEDC.

The next step is to bisect each line in that spherical segment and to draw a smooth curve, CFGB, connecting the points of bisection. When that is done the distances, PC and PB, are halved, the points of bisection being marked B_1 and C_1 respectively on Fig. 4. Through B_1 and C_1 semicircles are drawn with radii, $PB_1 = B_1B = PC_1 = C_1C$. The points of angle trisection must be very close to F and G, where the semicircles cross the curve, BGFC. This method is quite accurate for small angles but is not acceptable to a mathematician as a "solution" because the curve, BGFC, is not "drawn in one sweep" but is established point for point. The construction makes possible a very close approximation but does not yield the required points of mathematical trisection.

Another very fine approximate method, which has the additional advantage that it can also be adapted to cut an angle into five or seven equal sections, was found some 20 years ago by a retired colonel and is shown in Fig. 5. First, a number of circles (or sections of circles) are drawn around the vertex of the angle to be trisected, BPC, in Fig. 5. Then an arbitrary distance, WX, is selected

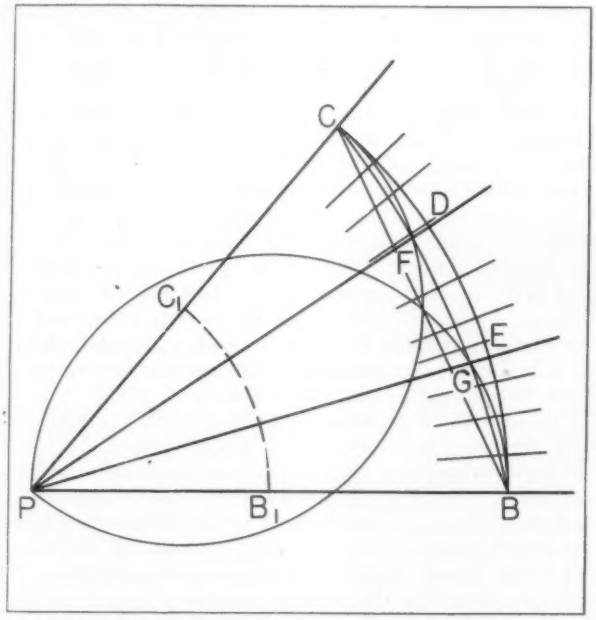


Fig. 4 — Another method of approximate angle trisection may be achieved by drawing arc BEDC and connecting B and C with a straight line. Curve BGFC is constructed midway between the straight line, BC, and the arc, BEDC. Points B_1 and C_1, bisecting distances PB and PC, respectively, are located, and through them semicircles are drawn with radii equal to PB_1. The points where the semicircles cut the curve, BGFC, locate points G and F, marking the approximate trisection of angle BPC.

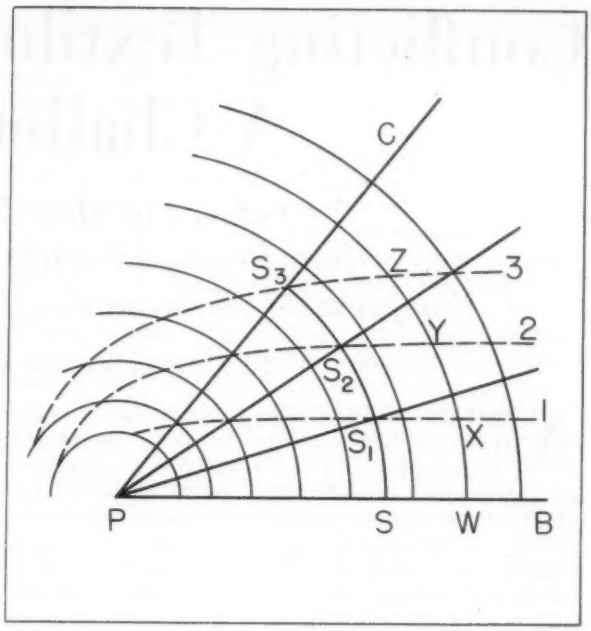


Fig. 5 — The numbered curves are constructed by laying off equal chords on circular arcs drawn about P, beginning at one leg of the angle to be divided. Where curve 3 cuts the other leg, an arc, SS_3, is drawn. The intersection of this arc with curves 1 and 2 establish points S_1 and S_2 which, when connected to the vertex, provide approximate trisection of the given angle. The method can be extended to dividing the given angle into any integral number of approximately equal angles.

and laid off three times on the arcs of each of the circles, beginning at one leg of the angle. While that distance is arbitrary in itself, it is, of course, important that it is the same all through the operation, that is, WX = XY = YZ. Connecting these points, one gets three (dashed) curves which are numbered 1 to 3 from bottom to top. At the point, S_3, where curve 3 crosses the upper leg on the angle, an arc, $SS_1S_2S_3$, is drawn. The two points, S_1 and S_2, where curves 1 and 2 cross the arc, are the approximate trisection points. This method is mathematically unacceptable for the same reason as the preceding method. It is good for practical purposes, however, and, as has been mentioned above, it can be adapted to divide an angle into five, seven, or any other number of sections by constructing the required number of dashed lines as indicated above.

Several useful methods (Figs. 3, 4, and 5) for trisecting an acute angle with sufficient precision for practical purposes have been given. As for the strictly mathematical trisection, it might have been mentioned earlier that that problem was solved many years ago. The ancient Greeks knew most of the simpler cases for which trisection could be accurately accomplished with only a compass and a straight edge. In 1801 Karl Friedrich Gauss stated all cases of angle trisection for angles containing a rational number of degrees. The first proof that accurate trisection with compass and ruler is impossible, in general, was given by the French mathematician, Pierre Laurent Wantzel, in 1837, but other proofs have been given since then.†

† Klein, Felix, *Famous Problems of Elementary Geometry* (Boston: Ginn and Company, 1897); second edition with notes by R. C. Archibald (New York: Stechert-Hafner, Inc., 1930), $1.50.

Conflicting Textile Requirements — A Challenge to the Scientist

Fabrics to Meet New Requirements Often Require Textile Designers to Engage in Compromise, Elimination, Circumvention, and Synthesis

By Stanley Backer and Norman E. Roberts

AMONG the country's leading manufacturing groups is the textile industry, producing a constant flow of utilitarian and ornamental items of apparel and furnishings, as well as articles of industrial use which have secured for themselves a vital place in everyday living. Although the fact is normally overlooked, there is not a single branch of commercial enterprise having a comparable effect upon our civilized existence, with the possible exception of food. And even here we must observe that we are constantly clothed, although our meals are served only thrice daily. In view of the paramount place of textiles in modern living, it would seem important that we understand some of the problems connected with the development of the clothes we wear, the linens in our homes, the curtains at our windows, the rugs beneath our feet.

These are hardly the products of modern invention. They have figured prominently in past civilizations and often serve as prime historical documents to those undertaking research into the realms of antiquity. The fabric properties to which we are accustomed are the result of centuries of experimentation and have been achieved only through constant modification in the manufacturing processes involved. The advances, however, have been made in the field of industrial technology. Until recently, little basic science has been utilized in the development of superior textile structures — the engineer, chemist, and physicist exhibiting almost complete indifference to problems of fabric improvement.

In World War I, America found herself isolated from European textile manufacturing facilities and cut off from the all-important sources of dyes on the Continent. Forced into a program of concentrated research, improvement, and revision of its techniques to provide the necessary independence, the United States soon exploded the myth of European superiority in these technological fields. During the period between World War I and II, American industry persisted in this spirit of scientific self-sufficiency until in 1941 it was well equipped to meet military requirements as they were then understood. This chronological aspect is stressed, for our knowledge has fallen behind the demands made on it in the solution of problems uncovered during World War II and in recent arctic maneuvers. Many serious weak points have become apparent in the textile materials designed for special uses.

The well-worn expression that we have "scraped the bottom of the barrel" of basic knowledge can be voiced with respect to our textile problems, for we have exhausted the information which appears most applicable. However, concentration on fundamental studies to the exclusion of further applied research would not only be impracticable from an economic point of view, but would presuppose an unjustified confidence in our coverage of previous basic work and its interpretation. What has occurred, in fact, is an orientation of many minds engaged in textile research with respect to a number of well-defined problems. Such clarification of objectives has led to some basic questions which heretofore have not only been unanswered, but even have been unasked.

Conflicting requirements imposed on a fabric designed for a definite end use, which in their accomplishment tend to counteract each other, have formed the basis for many of these questions. A case in point is the waterproof-coated fabric used in Army raincoats during World War II at the expense of free evaporation of body perspiration. In some instances, we require a reversal of properties, depending upon the conditions under which the article is to be used. Sleeping bags, indispensable for outdoor living in cold regions, furnish an example of this situation. Careful analysis of the requirements for an ideal filling material for these items indicated the desirability of low density and little compressibility. Excessive compressibility of the fill, at pressures up to three pounds per square inch, such as are incurred at body protrusions when the occupant is lying down, results in loss of thickness in the bottom portion of the bag and significant reduction in insulating properties. When the sleeping bag is not in use, however, the highest degree of compressibility is sought so as to avoid excessive bulk in portage. In effect, we seek a material which is soft, not too compressible in use, and highly compressible during storage and transportation.

Faced with the problem of meeting requirements which are at variance in known materials, the engineer, chemist, or physicist has open to him four basic approaches which we may arbitrarily designate as compromise, elimination, circumvention, and synthesis. A review of these methods of attack, together with concrete examples of their application, should furnish us with some understanding of the complexity of the problem involved, as well as an appreciation of the balance of the research program undertaken by the armed forces.

Compromise, in this case, involves careful study of the factors responsible for the conflicting requirements and selection of a base material, construction, and finish which will assure optimum performance in each characteristic consistent with over-all efficiency. The minimum

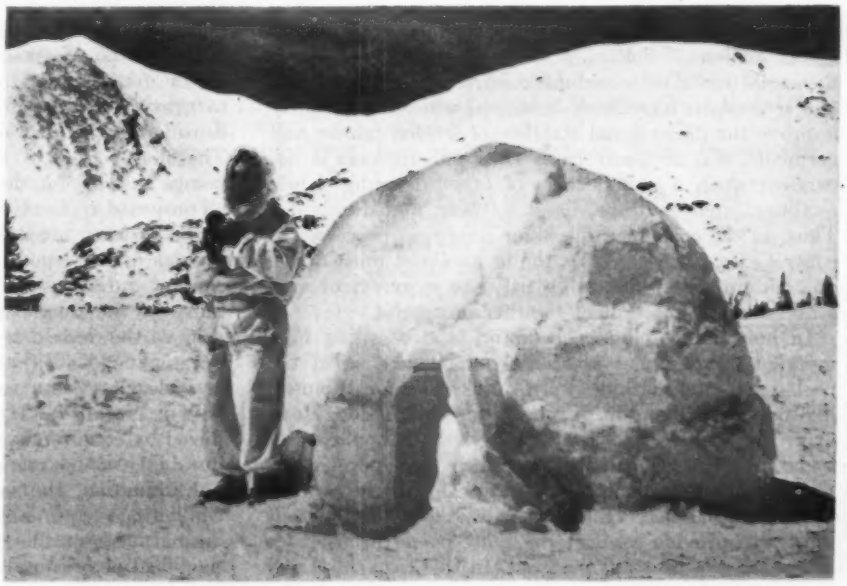
functional limits of a single property serve as the base point above which compromise takes effect. One of the many examples of textile structures, in which opposing properties are desired, is fabric intended to provide fire resistance. Conditions imposed by modern warfare have made this a vital property for many items of clothing and equipage to be used in combat. It has been indicated by the action of several state legislatures that flame-resistant materials may also become important from a civilian standpoint, particularly with regard to children's clothing and decorative materials.

In reducing fabric flammability there are basically two phenomena which must be controlled — afterflame and afterglow. Continued afterflame will, of course, ultimately consume the fabric, while a long period of afterglow will destroy the material by charring. As a result of extensive research some relatively effective fire-resistant compounds for fabric application have been developed, but a fundamental study of the problem involved has revealed a definite conflict between the requirements for any such treatment. To retard afterflame, the finish should be of such a character that it will produce a predominance of carbon dioxide when the fabric is ignited. However, to reduce afterglow, formation of carbon monoxide is desired. Conversely, production of carbon monoxide contributes to afterflame, while formation of carbon dioxide encourages afterglow. Therefore, a treatment which effectively checks afterflame by the creation of carbon dioxide will, by its very nature, tend to propagate afterglow. The present direction of military research in the face of this situation is toward compromise; the development of improved fire-resistant treatments which will retard afterflame to the most effective degree consistent with a minimum of afterglow.

Technologists working in the field of water resistance of textiles are also seeking to find the most satisfactory compromise between a perplexing set of conflicting properties. Protecting an individual from wetness is a dual problem involving resistance to water penetration from the outside of the outer garment to the underclothing, and provision for free passage of perspiration-vapor from the skin. The creation of an impenetrable barrier, such as is achieved by the use of coated fabrics or plastic films for waterproofing, would provide maximum resistance to rain penetration. But such materials are extremely low in vapor permeability and cause the wearer as much discomfort by trapped perspiration as would be experienced if inadequate rain protection were provided. This is also a problem in cold regions where underclothing, which becomes damp from rain penetration or perspiration, sustains a significant loss in insulating properties. The answer to this conflict to date has been in the application of water-repellent treatments which cover the fibers and yarns with a hydrophobic surface without blocking fabric interstices. Thus, air- and water-vapor permeability are retained while considerable resistance to rain penetration is provided. In other words, a compromise is reached between the completely waterproof structure and the porous water-vapor permeable material.

To obtain best results from the use of these water-repellent treatments, however, tightly woven fabrics are required so as to reduce the average pore size between yarns. In attempting to move in the direction of a denser weave than is normally used, the textile engineer is first confronted with economic factors and practical plant capacities which are serious deterrents to such a development. Even if these obstacles were to be overcome, the necessity for reaching another compromise would soon become evident in that the increased water resistance of the tighter construction would be largely vitiated by poorer drape characteristics and lowered tear resistance.

The features which distinguish a piece of woven fabric from any other sheet material are complete flexibility and drape, or capacity for assuming a three-dimensional shape without buckling. The freedom of interplay between fibers and yarn, and yarn and fabric, are such as to disguise or circumvent the inherent properties of the fiber. As an illustration, compare a fabric woven of ultra-fine glass fiber and a pane of glass. Although both are made of the same material, the former is a loosely woven, soft, flexible, tailorable (having good drape), tear-resist-



Warmth with a minimum of weight is sought in clothing for use in cold climates. In usual fabrics, thermal insulation is related directly to fabric weight but improvements in the former were made without increasing the weight by producing a fluffy surface over the fabric plane somewhat in imitation of natural furs.

In other developments, fine synthetic fibers were quilted between wind-resistant fabrics for padded clothing having a desirably high ratio of warmth to weight.

Official Signal Corps Photo

Thin, light, porous fabrics provide the coolness of clothing which is required in the humid, tropical climates but unfortunately do not simultaneously provide the very much needed protection against insects. The density of fabric needed to provide protection against insects, in turn, increases weight and warmth.

To meet these two conflicting requirements, a compromise was made in the selection of tightly woven poplin for clothing.

Official Signal Corps Photo

ant, and permeable fabric; the latter, a rigid, inflexible, impermeable body with low tear or shear resistance. In achieving maximum packing of yarns in weaving, the material undergoes a gradual transition from textile-like to papery to film-like qualities.

In seeking a fabric for its field jacket in 1943, the Army made a sacrifice in tailorability, flexibility, and tear resistance in favor of improved water resistance when it selected an oxford weave styled after the English cloths developed at the Shirley Institute. It was not willing to make such a compromise, however, in its choice of an outer fabric for the trench coat in which drape and appearance were important factors. In this instance, the oxford weave was rejected in favor of a sateen material. Inasmuch as civilian demands, with respect to tailorability, far exceed those of the armed forces, there is little likelihood that water resistance achieved at the expense of appearance and comfort would find commercial acceptance.

Shrinkage in laundering has been responsible for the loss of millions of dollars' worth of garments long before the expiration of their useful life. Shrink-resistant finishes and treatments have been developed which significantly improve the dimensional stability of woolen fabrics and garments, but in many cases their effectiveness is dependent upon a modification of other desirable fabric qualities, such as drape, hand softness, and durability. Thus, in the continued quest for improved processes to control excessive shrinkage, the technologist must arrive at a compromise which will satisfy one requirement with a minimum of impairment to other properties.

In hot, humid climates, comfort and resulting high morale of the soldier are largely dependent upon the coolness of the clothing worn. This calls for thinness, lightness, and high porosity in fabric construction. However, tropical insects (particularly the Anopheles or malaria-breeding mosquito) find such thin, porous materials an easily penetrable barrier for their probing proboscises. Hence, against the desire for thin, porous fabrics to provide comfort, we must place the need for a dense insect-resistant material. In this case the Army has sought to compromise the two requirements by adopting for tropical uniforms a lightweight but tightly woven five-ounce poplin, such as that chosen by Admiral Byrd for its lightness and wind resistance.

Another example of conflict between properties leading to good appearance and other characteristics is afforded by dress fabrics for tropical- or summer-temperature climate wear. Since insect resistance is not a consideration for such materials, they are chosen primarily for their appearance and comfort. Thin, light, and open constructions, such as the tropical worsteds, are the obvious answer to this need. However, the requirement for opacity must also be considered, for the fabric must be of sufficient body to conceal the color and shape of undergarments. Since such opacity is attained only through closeness and density of weave, another conflict among properties is created. Experiments are being conducted at present to establish the limits of opacity and body consistent with thinness and permeability.

Attack of cellulosic structures in the tropics by microorganisms posed an urgent problem to the producers of textile materials for the armed forces. Fungicidal agents to control or prevent mildew growth were first to be considered but, here again, conflict was encountered. The most effective treatments were toxic to human beings in varying degrees. Thus, careful screening of all proposed applications was necessary to prevent serious dermatological aftereffects upon personnel handling the textiles in subsequent fabrication processes and also in contact during use. Furthermore, some degree of solubility of the fungicide had to be retained in order to achieve the desired resistance. This, in turn, resulted in progressive loss of the agent in laundering of the garment or in leaching as a result of rainfall. During the major part of World War II, damage to textile stores was minimized by compromising between toxicity, solubility, and durability of the fungicides accepted by the armed forces.

Elimination, the second approach to the problem of conflicting requirements, consists of analysis of the desired incompatible characteristics with a view to their modification or complete elimina- (*Continued on page 406*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Trek to Tech

JUNE 12 will be Alumni Day, 1948, when M.I.T. graduates from all corners of the country will return to the Institute to renew acquaintances, to attend a symposium on "Logistics of Peace," and to partake of the ever welcome Stein Banquet at Boston's Hotel Statler in the evening.

William W. Garth, Jr., '36, chairman of Alumni Day, reports satisfactory progress in completing plans for this event. To assist Mr. Garth in the manifold details to which attention must be given to assure a smoothly functioning affair, the following committees have been appointed:

Banquet: Edmund B. Fritz, '32, chairman, William H. Carlisle, Jr., '28, Allen Latham, Jr., '30, James B. Smith, '32, Robert L. Johnson, '38, and Lewis T. Jester, Jr., '41; *Class Day:* John A. Hrones, '34, chairman, Eugene Mirabelli, '19, and Kenneth R. Wadleigh, '43; *Exhibits:* Herbert L. Beckwith, '26, chairman, John E. Burchard, '23, Richard M. Bissell, Jr., Staff, Robert J. Hansen, Staff, Gyorgy Kepes, Staff, Norman J. Padelford, Staff, Walter S. Pierce, Staff, and Robert R. Shrock, Staff; *Ladies' Program:* Mrs. B. Alden Thresher, chairman, Mrs. Raymond H. Blanchard, Mrs. Horatio L. Bond, Mrs. Karl T. Compton, Mrs. Marshall B. Dalton, Mrs. Lester D. Gardner, Mrs. William W. Garth, Jr., Mrs. James R. Killian, Jr., and Mrs. George W. Treat; *Luncheon:* John B. Wilbur, '26, chairman, Flint Taylor, '26, William J. Kirk, '28, and Ariel A. Thomas, '36; *Publicity:* Ralph T. Jope, '28, chairman, Henry B. Kane, '24, James Donovan, '28, Beverly Dudley, '35, and John J. Rowlands, Staff; *Registration:* Wolcott A. Hokanson, Staff, chairman, John N. Higgins, '31, and Donald P. Severance, '38; *Symposium Arrangements:* Donald Whiston, '32, chairman, G. Edward Nealand, '32, and William H. Radford, '32; *Transportation:* Malcolm S. Stevens, '34, chairman, Emmons J. Whitcomb, '11, and John C. Leslie, '28; *Ways and Means:* Delbert L. Rhind, Staff, chairman, Carl M. F. Peterson, '29, and Horace S. Ford, Staff; *Stein Design:* Henry B. Kane, '24.

The day's events will begin with registration of Alumni in the main building of the Institute. The morning will be available for visiting the several exhibits which are being planned for Alumni Day: some of the more popular laboratories will also be open for inspection.

At noon, Alumni will have opportunity to renew old acquaintances at the luncheon in the Great Court.

Outstanding speakers will discuss the economic, political, and military factors underlying international peace in an afternoon symposium, "Logistics of Peace," to be held in Walker Memorial.

Boston's Hotel Statler will be the scene of the ever popular "Stein-on-the-Table" Banquet, with a newly designed 1948 stein for all who attend. Persons prominent in the State Department will give the banquet addresses, and President Compton will deliver his annual report.

Open House

INTERRUPTED during the war years, the traditional spring Open House will be resumed this year when the Institute will open its doors and become host to thousands of visitors on Saturday, May 1. Exhibits, lectures, demonstrations, and guided tours are being planned to show the latest developments in science and engineering as well as student life at M.I.T.

Students will serve as hosts and, with the assistance of Faculty advisers, will conduct and plan many of the exhibits. Those technical features which, in past years, have drawn as many as 35,000 visitors to M.I.T. grounds in a single day will, of course, be a feature of Open House.

The classroom and laboratory, however, represent but one side of life at the Institute, and guests will have an opportunity as well to witness many of the extracurricular activities in which M.I.T. students engage.

Class Reunions

The secretaries of the following classes have announced reunions and get-togethers to be held as noted below:

1888 In celebration of their 60th anniversary. Tentative date is the week end of Alumni Day, June 12. Details will be announced later.

1893 June 11, The Country Club, Brookline, Mass.

1898 June 9–12. Headquarters at the Parker House, Boston. June 9, Babson Institute; June 10, The Country Club in Brookline; June 11, Commencement at M.I.T.; June 12, Alumni Day at M.I.T.

1903 June 11. The Class Secretary, Frederic A. Eustis, and Mrs. Eustis, invite classmates, their wives, and daughters to a 45th anniversary party at their home, 1452 Canton Avenue, Milton 86, Mass. Time: 5:00–9:00 P.M.

1905 June 18–20, East Bay Lodge, Osterville, Mass.

1908 June 9–11, Oyster Harbors Club, Osterville, Mass.

1913 June 11–13, New Ocean House, Swampscott, Mass.

1918 June 11–13, Cliff House, Scituate, Mass.

1921 June 12, Hotel Statler, Boston. A get-together at 4:00 P.M.

1923 June 13–16, The Griswold Hotel and Country Club, New London, Conn.

1928 June 25–27, Wianno Club, Wianno (Osterville), Mass.

1933 June 10 to morning of June 12, East Bay Lodge, Osterville, Mass.

1938 June 10–12, Mayflower Hotel, Plymouth, Mass.

1943 June 11. Dinner in the Campus Room, Graduate House, M.I.T., at 7:30 P.M. Assembly at 6:30 P.M.

Please consult individual class secretaries for additional information.

The Educational Elite

CONGRATULATIONS are in order for 10 Faculty members recently promoted to full professorship, to 12 advanced to associate professor, and to 10 recently made assistant professor. In addition, 13 members of the staff were made instructors, according to President Compton.

Members of the Faculty promoted to the rank of professor are:

Shatswell Ober, '16 ..... Department of Aeronautical Engineering
Ernst A. Hauser ..... Department of Chemical Engineering
Arthur T. Ippen ..... Department of Civil and Sanitary Engineering
Richard M. Bissell, Jr. ..... Department of Economics and Social Science
Douglas M. McGregor ..... Department of Economics and Social Science
Harold E. Edgerton, '27 ..... Department of Electrical Engineering
William C. Greene ..... Department of English and History
Witold Hurewicz ..... Department of Mathematics
William R. Hawthorne, '39 ..... Department of Mechanical Engineering
John A. Hrones, '34 ..... Department of Mechanical Engineering

Members of the Faculty who were promoted to the rank of associate professor are:

Raymond L. Bisplinghoff ..... Department of Aeronautical Engineering
William R. Weems, '35 ..... Department of Aeronautical Engineering
Lawrence B. Arguimbau ..... Department of Electrical Engineering
Yuk Wing Lee, '27 ..... Department of Electrical Engineering
Henry J. Zimmermann, '42 ..... Department of Electrical Engineering
George de Santillana ..... Department of English and History
Douglas P. Adams ..... Section of Graphics
John T. Burwell, Jr., '34 ..... Department of Mechanical Engineering
Michael B. Bever, '42 ..... Department of Metallurgy
Nicholas J. Grant ..... Department of Metallurgy
Delbar P. Keily, '34 ..... Department of Meteorology
Laszlo Tisza ..... Department of Physics

Newly appointed assistant professors are:

Howard Simpson ..... Department of Building Engineering and Construction
Carroll J. Brown, 9–46 .. Department of Business and Engineering Administration
Charles G. Swain ..... Department of Chemistry
Benjamin J. Dasher ..... Department of Electrical Engineering
Robert H. Eustis ..... Department of Mechanical Engineering
Herman Klugman ..... Department of Modern Languages

Professorship promotions recently announced include (top to bottom and left to right): *Richard M. Bissell, Jr., Professor of Economics; Harold E. Edgerton, '27, Professor of Electrical Measurements; William C. Greene, Professor of English; Ernst A. Hauser, Professor of Chemical Engineering; and William R. Hawthorne, '39, Professor of Mechanical Engineering.*

David H. Frisch ..... Department of Physics
Matthew L. Sands ..... Department of Physics
Malcolm W. P. Strandberg ..... Department of Physics
Robert W. Williams, '48 ..... Department of Physics

Members of the staff who were promoted to the rank of instructor are:

Elmer E. Larrabee ..... Department of Aeronautical Engineering
Henry M. Paynter, Jr., 10–44 ..... Department of Civil and Sanitary Engineering
Henry C. Bourne, Jr., '47 ..... Department of Electrical Engineering
Wilbur R. DeHart, 6–46 ..... Department of Electrical Engineering
James H. Henry ..... Department of Electrical Engineering
Leon G. Kraft, Jr. ..... Department of Electrical Engineering
Robert B. Wilcox ..... Department of Electrical Engineering
Robert B. Davis, 9–46 ..... Department of Mathematics
Raymond M. Redheffer, '43 ..... Department of Mathematics
Oliver G. Selfridge, 6–45 ..... Department of Mathematics
Robert B. Jacobs, 2–46 ..... Department of Mechanical Engineering
Ethan A. Murphy ..... Department of Meteorology
Lester A. Siegal, 10–44 ..... Department of Physics

Westinghouse Professorship

WILLIAM R. HAWTHORNE, '39, Professor of Mechanical Engineering at M.I.T., has been appointed to the new Faculty post of George Westinghouse Professor of Mechanical Engineering. Dr. Hawthorne, who was recently awarded the Medal of Freedom with bronze palm by the War Department, is internationally known for his work in the field of jet propulsion, gas turbines, and combustion.

The establishment of the George Westinghouse Professorship at M.I.T. was announced last fall when the new Gas Turbine Laboratory was dedicated. This new post was made possible by a grant from the Westinghouse Educational Foundation. It provides for study and research in the constantly expanding field that has grown up about the development of gas turbines and related fields of mechanical engineering.

Born in Benton, England, in 1913, Dr. Hawthorne attended Trinity College, Cambridge University, where in 1934 he received the degree of bachelor of arts. He then came to M.I.T. as a Commonwealth Fund Fellow and completed work for his doctor of science degree in fuel engineering in 1939. He joined the staff of the institute as associate professor of mechanical engineering in 1946.

Full professorship has recently been announced for (left to right and bottom to top): *John A. Hrones, '34, Professor of Mechanical Engineering; Witold Hurewicz, Professor of Mathematics; Arthur T. Ippen, Professor of Hydraulics; Douglas M. McGregor, Professor of Psychology; and Shatswell Ober, '16, Professor of Aeronautical Engineering.*

Construction of the Charles Hayden Memorial Library, which will serve not only as a great repository of scientific and engineering knowledge, but as a center of the humanities and social science program at M.I.T., was begun on April 5. The event was marked by a ground-breaking ceremony in which President Compton, Ralph T. Walker, '11, representing the architects, Voorhees, Walker, Foley, and Smith of New York, and J. Willard Hayden, President, and the trustee of the Charles Hayden Foundation, (left to right) *played an active role. Representatives of the Thompson-Starrett Company, who will construct the library; James R. Killian, Jr., '26, Vice-president of the Institute; John E. Burchard, '23, Director of Libraries; Vernon D. Tate, Librarian; and members of the administrative offices and library staff were present at the ceremony. A model of the new library was first shown publicly at this time.*

The library will be a memorial to the late Charles Hayden, a member of the Class of 1890, whose lifelong interest in M.I.T. will thus be perpetuated. Construction of the library is made possible by a gift of $2,200,000 which came to the Institute through the generosity of J. Willard Hayden who broke ground for the new structure.

The new building will occupy a site between the main educational buildings of the Institute and Walker Memorial, and will face the Charles River Basin. In addition to its basic purpose as a center of management and reference for one of the country's largest engineering collections, the library will provide facilities for four divisional libraries in the humanities. It will also serve as a center of research on scientific aids to learning, including the laboratories supported by a $100,000 grant recently made by the Carnegie Corporation. Present plans indicate that the building will be ready for occupancy in the autumn of 1949.

The design of the Hayden Memorial Library had the advantage of penetrating study by the Co-operative Committee on Library Building Plans, which is made up of representatives of such institutions as Harvard, Princeton, Pennsylvania, California, Duke, North Carolina, Iowa, Wisconsin, Michigan, Rice Institute, and M.I.T., over a period of more than two years during which the plans were perfected. The work of this committee, which was supported by a grant from the Rockefeller Foundation for the purpose of such a study, has materially influenced the scope and design of the new building which is expected to set a new standard in university library facilities.

Real and Imaginary

MEETING in the Campus Room of the Graduate House on the last Monday in March, for its 261st session, were 112 members of the Alumni Council who broke bread, and in the business portion of the meeting, took action on reports, listened to President Compton liken the Institute to a complex quantity, and heard C. Richard Soderberg, '20, trace the history of heat engines from Newcomen to jet propulsion. Raymond H. Blanchard, '17, President of the Alumni Association, was chairman for the evening. Introduced, as guests of the meeting, were Roscoe H. Smith, '23, President of the M.I.T. Association of Cleveland, and Daniel F. Flowers, a graduate student in Mechanical Engineering.

The business session was given to reports in which Charles E Locke, '96, Secretary, announced that 11 members of the Institute's staff visited 19 alumni clubs from Montreal to Mexico City during February and March. Also announced was the Executive Committee's authorization of a tentative form of constitution for class organization, the use of which is optional with each class.

Henry B. Kane, '24, Director of the Alumni Fund, announced that the eighth year of the Alumni Fund closed with a total of $206,366 contributed by 9,771 Alumni. Although the amount contributed was $21,000 in excess of last year's record, the number of contributors dropped about two per cent.

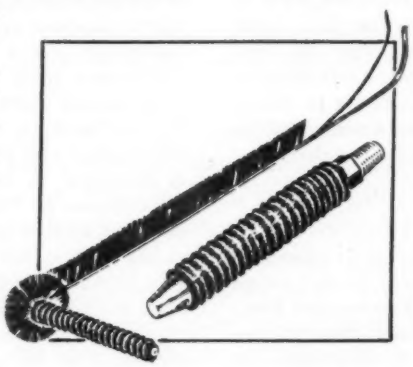
In recounting recent work of the Administration, President Compton compared the Institute's operations to a complex quantity — the real part of which is represented by present educational activities and building programs, whereas the less tangible factors of future planning and the budget take on the characteristics of the imaginary component. Dealing first with the real quantities, President Compton reported that the new field house was being rapidly completed on Vassar Street, adjacent to the Massachusetts State Armory, as was also the supersonic wind tunnel, near the Cottage Farm Bridge. The new Senior House on Memorial Drive is expected to be ready for occupancy in the fall. Reported as a future activity, which has since become history, is the breaking of ground for the Charles Hayden Memorial Library, illustrated above.

Not so familiar but nevertheless just as "real" are the imaginary quantities relating to the Institute's operations. These include such topics as increasing costs of operations, budgetary matters, and the future stabilized enrollment. These topics are "imaginary" only in the sense that they represent plans and expectations rather than accomplished facts. It is estimated that student enrollment will drop to about 4,900 next fall and that by next year it will be possible (*Continued on page 386*)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Probably few people realize that the dairy industry is a large user of special brushes. In pasteurizing and bottling plants milk flows through pipes and tubes, and these must be thoroughly scrubbed inside, using small cylindrical brushes attached to rods. Naturally, the brushes themselves must be capable of sterilization, which means a metal back. Conventional tufted brushes do a good job, but a famous manufacturer realized that a better job would result if it could make a brush by holding the bristles in a channel, and then winding the straight brush into a small, tight spiral. Experiments immediately showed, however, that there was a lower limit to the radius obtainable without cracking the metal and loosening the bristles. That limit, unfortunately, was considerably above the radius necessary to make a brush that would have an outside diameter, over the bristles, of $\frac{3}{4}$" and an inside diameter, over the mandrel, of $\frac{3}{16}$".



It was at this point that Revere was called in. Did we know of any metal or alloy which would withstand such a double deformation? Remember, Revere was told, the metal first must be turned up into a channel, enclosing a brass wire around which the bristles are set. Then the channel must be bent on its back in a tight coil with that small inside diameter of $\frac{3}{16}$". Was there anything that would take this abuse and not crack, split, break, or open the bristle-filled channel?

Anybody could see that this was a tough problem. If annealing could have been resorted to, perhaps the operation would not have been considered too difficult, but you can't anneal bristles. The metal had to be taken as it came from the mill, made to do that double flip-flop, and make a perfect brush.

If you had been the brush manufacturer, we trust you would have done what he did—come to Revere for help. If you had been Revere, you would have done just what we did—study the characteristics of all the Revere Metals and Alloys, seeking one that would have the required strength and toughness, plus maximum corrosion-resistance.

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This is but one example that shows how a supplier can collaborate with his customers to mutual benefit. Revere is not alone in carrying on such activities. Every supplier, no matter whether he produces metals or woods, chemicals or plastics, rubber or glass, inevitably knows a great deal indeed about his materials and how to work them into finished products. The great essential is that he be fully informed as to methods and end uses, for only then can he turn his knowledge and experience to your benefit.

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THE INSTITUTE GAZETTE

(*Continued from page 384*)

to effect a still further reduction to 4,500, the present postwar goal. A deficit which may be as much as $60,000 is expected from operations of the current year, but this will be met by drawing on the accumulated income from special funds which were little used during World War II. The real crisis in budgetary operations is expected to come in two or three years, but plans to meet the anticipated deficits are now being laid.

Following President Compton was Professor C. Richard Soderberg, Head of the Department of Mechanical Engineering, who traced the history and development of heat-power engines from the early Newcomen engine and Watt condenser to the modern gas turbine. Significant developments in this field were found to be correlated with progress in economic and political history, and, in turn, steam and other heat engines greatly increased the market for power, expanded industrial production in factories, and accelerated the industrial revolution. The statement of the principle of the conservation of energy in 1842 opened the way for Carnot to deduce the theoretical limit of efficiency of heat engines which, in turn, made possible appreciable improvements in the potentialities of the steam engine. The first steam turbine appeared in 1875, the first Diesel engine in 1895, and much progress in airplane engines was made between the two World Wars. By 1940 developments in metallurgy, mechanical engineering, and physics made possible the development of gas turbines during the last decade.

Atomic Energy Engineering

GRADUATE training in the engineering aspects of atomic energy took a step forward in the recent establishment of an M.I.T. School of Engineering Practice in the production plants of the Atomic Energy Commission at Oak Ridge, Tenn. Thomas K. Sherwood, '24, Dean of Engineering at M.I.T., stated that the purpose of the school is the education of graduate students in several fields of engineering under a program which is designed to develop their ability to apply basic principles to the solution of technical problems encountered in industry, with emphasis on the engineering aspects of atomic energy.

It is not anticipated that nuclear engineering will become a separate branch in the same sense as civil, mechanical, electrical, or chemical engineering. The plants of the Atomic Energy Commission constitute a very large industry, requiring engineers with basic training in the established engineering fields. The Engineering Practice School is designed to provide these men with a varied plant experience which would better prepare them for responsible engineering positions in the general field of atomic energy. The program is in accord with the announced policy of the Atomic Energy Commission to encourage education and the enlargement of both theoretical and practical knowledge relating to atomic energy.

Plans for the school were completed recently with officials of the Atomic Energy Commission and the Carbide and Carbon Chemicals Corporation which operates the Oak Ridge plant. The arrangements for the Graduate Engineering Practice School were made with the concurrence of the Oak Ridge Institute of Nuclear Studies which has a broad graduate training program at Oak Ridge in co-operation with its 14 member universities in the South and Southwest.

Admission to the new school is restricted to graduate students in the several engineering departments of the Institute who have been in residence at M.I.T. at least one term. The program is open only to United States citizens and every student must be cleared by the Atomic Energy Commission before he will be considered for admission to the School.

Students are expected to live as a group in a dormitory at Oak Ridge, and the period of residence for the term of the school will be approximately five months. The first group will begin their studies in July and the second will enter next February. Academic credit will be given for work at the Oak Ridge station. Since the time spent at the school will be devoted entirely to education, students will receive no compensation. They are expected to be assigned by the director to a considerable number of atomic energy plant problems during the period of the five months' course.

Professor Walter G. Whitman, '17, Head of the Institute's Department of Chemical Engineering, will be in charge of the new School of Engineering Practice, and the educational program at the Oak Ridge station of M.I.T. will be directed by William A. Reed, '43, Assistant Professor, with one or more assistant directors.

Professor Reed, the school's first director, is a native of Montana where he was born in 1920. He attended Harvard College from 1938 to 1942 under a national scholarship, and received his bachelor of science degree in chemistry in 1942. He then joined the staff of the Department of Chemical Engineering at M.I.T. as an assistant while working for the degree of master of science in his field, which was awarded in 1943. For the next year he was an instructor in his Department at the Institute, and from 1944 to 1946 he was working on a government project in the Department of Mechanical Engineering. In 1946 he was appointed research associate and carried on advanced work which led to the degree of doctor of science in Chemical Engineering in 1948. His appointment as assistant professor was made on February first this year.

Endorsement

AERONAUTICAL engineering, as taught at M.I.T., was carefully examined by six members of the Visiting Committee on the Department of Aeronautical Engineering who met at the Institute on May 23, 1947.*

The morning was spent in an inspection of the facilities now available to the Department for instruction and research. The Committee was pleased to note that the Department now occupies the entire Guggenheim Building and is using the excellently skylighted upper floor, vacated by the Department of Meteorology, for a design room. Examples of students' general design layouts and detail design of components were displayed by Professor Otto C. Koppen, '24, (*Continued on page 388*)

*Members of this Committee for 1946–1947 were: Gordon S. Rentschler (deceased) chairman, Godfrey L. Cabot, '81, Frank W. Caldwell, '12, B. Edwin Hutchinson, '09, Theodore P. Wright, '18, Ralph S. Damon, and Lawrence B. Richardson.

A Progress Report on Phase Microscopy

EVER since American Optical Company developed the first phase microscope to be shown in this country, scientists have awaited the day when it would be readily available.

The equipment revealed detail almost invisible under the ordinary microscope—particularly in unstained and living material. Bacteria, tissue cultures, blood, protozoa, textile fibers, minerals, crystalline substances, plastics and other transparent materials—all could be studied more effectively.

However, much work remained to provide suitable phase objectives for many specific purposes. Sales efforts were postponed in favor of continued development.

After years of research in cooperation with many leading scientists, the wisdom of this policy was demonstrated at the 1947 AAAS Convention in Chicago. Many visitors brought their own materials in which significant detail could be seen only under the Spencer Phase Microscope.

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THE INSTITUTE GAZETTE

(*Continued from page 386*)

and Frank K. Bentley, Assistant Professor of Aeronautical Engineering.

The aeronautical branch library was visited in its new location, which provides more space for reading tables, and the following laboratories were inspected: Instrumentation, Structures, Helicopter, Students' Wind Tunnel, Flutter Wind Tunnel, Wright Brothers Wind Tunnel, Gas Turbine, and Automotive. In each laboratory, typical experimental work was shown and the opportunity was taken to discuss, with the staff members in charge, the purpose and function of the laboratory in the Institute's educational program.

In the afternoon the Committee inspected the major research projects being carried on for the Army and Navy by groups under the direction of Professors Charles S. Draper, '26, and John R. Markham, '18.

A conference with administrative officers of the Institute and a few faculty members of the Department was held in the evening. Careful consideration was given to trends in the aeronautical industry involving new fields of aeronautical science. The balance between teaching and research is affected by the needs of the government for research bearing on national security, and this topic also received attention.

Research projects for the Army and Navy are in good balance with the educational program and are affording excellent opportunities for graduate students to undertake advanced work in the newer aspects of aeronautical science. Furthermore, postwar government-sponsored research encourages the search for new knowledge, which strengthens the Faculty and stimulates teaching. Continuation of government research projects as now controlled and on the existing balance of effort between the several types of activity of the Department is heartily recommended.

It was found that previous recommendations had been well implemented and the Committee was especially gratified to note the expanded space and facilities which are now available. In particular the extension of the graduate teaching program in supersonic aerodynamics, aeroelasticity and flutter, helicopters, gas turbines, and jet propulsion, and the addition of the staff of experts in these fields are most welcome.

The Committee was gratified to note the rapid progress which had been made toward completion of the Gas Turbine Laboratory and the enlargement of the Sloan Automotive and Aircraft Engine Laboratory. The latter should be able to handle double the former number of enrolled students.

If the interest shown by attendance at the courses justifies the expense, the Committee recommends supplementing the elective courses in helicopters with modest laboratory facilities for model experiments. It also recommends an advanced course in statistical mechanics as applied to gas dynamics, introductory courses in atomic and nuclear physics for eventual application to aircraft propulsion, and an elective dealing with rockets. The

(*Continued on page 390*)

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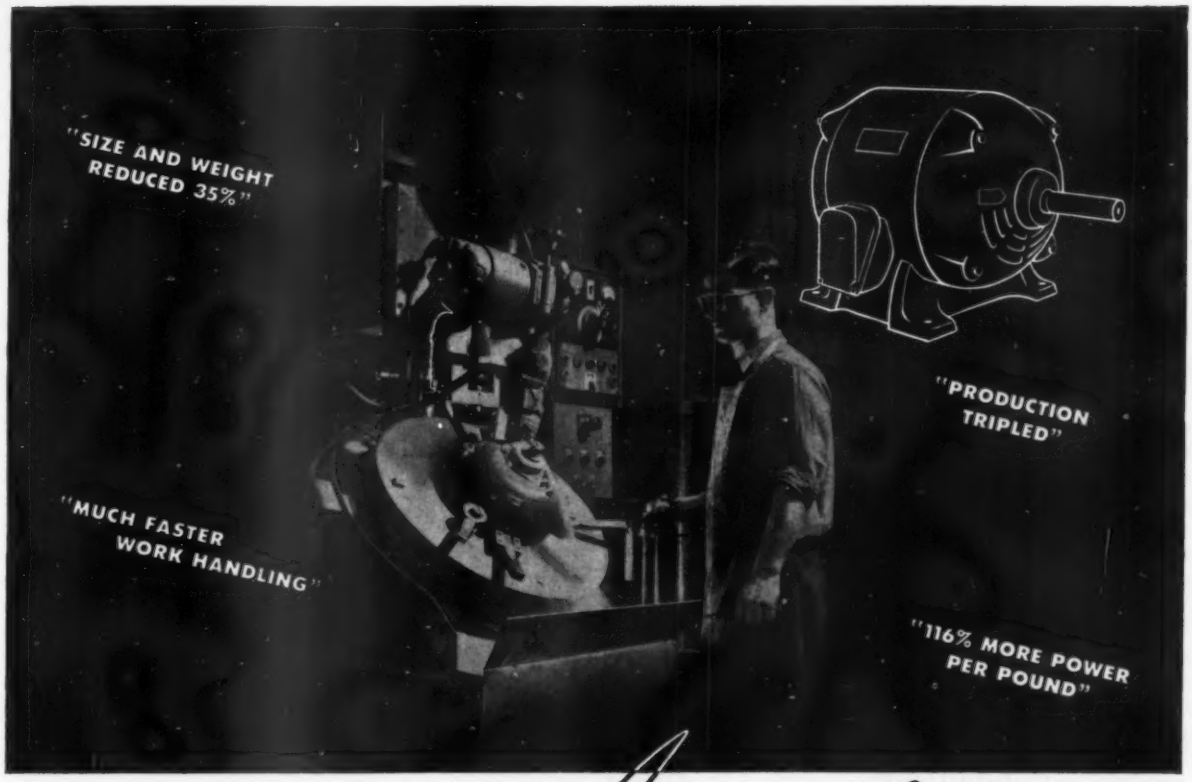

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THE INSTITUTE GAZETTE

(*Continued from page 388*)

Department's efforts to extend structural theory to include dynamic behavior and the development of appropriate courses of instruction are wholeheartedly endorsed, as is also continuation of the policy of limiting enrollment to an optimum number of promising students.

The Play's the Thing

By Ivan J. Geiger

THIS changing world demands versatility of its citizens. Modern society is so complicated that the greatest contributions to general welfare can be made by well-rounded individuals, even though increasing numbers of specialists are also required to play their role. It is important, therefore, that a scientist or engineer, for example, face society with something more than merely a specialized technical training. Such a person must understand human relations as well as mathematical equations and the technical language of his profession. In fact, full attainment of the professional status can be achieved only by participating intelligently in the events of society. But the accomplishment of professional status is not quickly or immediately reached. So it is that the primary problem of any educational institution is how best to equip its students to meet the changing social, economic, and industrial conditions of life. This problem confronts M.I.T. as well as it does any other institution of higher learning.

Technology is universally recognized as providing a first-class professional education in science, engineering, and architecture. For many years M.I.T. has also required its students to study subjects in the humanities and to engage in extracurricular student affairs as effective methods for building well-rounded individuals. Throughout the years its athletic program has had as its objective the development of healthy, agile bodies in its students rather than the winning of the majority of games in collegiate competitions. Recent changes in the administration of student athletics, as already recorded in The Review * make possible a further expansion of student participation in athletics, the primary purpose of which is to make its own contribution in the student's development while he is attending M.I.T. There is ample evidence to show that desirable physical, social, and moral traits can be developed, emotional control can be practiced, and good recreational habits can be formed by students through active participation in a sane and properly administered athletic program.

Problematical situations of a social, moral, and physical nature occur frequently and with deep impact during competition in athletic games. Such participation in competitive activities affords the student opportunities for practice in getting along with his fellow man, in developing leadership, co-operation, team play, and desirable physical and recreational habits. From day to day it contributes to the feeling of well-being, which, in turn,

* The Technology Review: "Director of Athletics," June, 1947, page 474; "To Broaden the Man," July, 1947, page 544; "Athletic Board Replaces Advisory Council," January, 1948, page 162; "To Direct Athletics," February, 1948, page 213.

(*Continued on page 392*)

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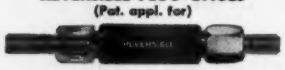

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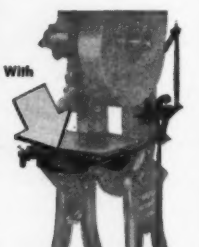

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THE INSTITUTE GAZETTE

(Continued from page 390)

increases the student's health and professional efficiency. The acquisition of professional and technical knowledge is of primary importance, of course, and no extracurricular activity should interfere with this primary objective. The ability to impart and use his education in its broadest sense requires considerable social, moral, and technical adjustments. Such balance is able to benefit most students, and it is to this end that athletics at M.I.T. makes its major contribution.

To carry out such a program, the aim at the Institute is to provide a sport for every man and a man for every sport; the objective is the further promotion of physical fitness, social efficiency, and culture.

Physical fitness requires the development and maintenance of a sound physique and soundly functioning organs to the end that the individual realizes, in optimum measure, his capacity for physical activity as well as for mental accomplishments, unhampered by deficiencies in physical strength and vitality. The development of desirable standards of conduct and ability to get along with others may also be expected to be advanced by proper athletic participation. A socially efficient individual is one who functions harmoniously within himself, in his relationship to others, and as a member of the society of which he is a part. Finally, the enrichment of human experience through physical activities that lead to the better understanding and appreciation of the environment in which men and women find themselves, and the development of recreational competency for leisure should be another end result of properly administered athletic programs.

At M.I.T. attempts to realize these objectives take one or more of three forms, depending upon the needs and desires of the students: (1) required program of athletics for freshmen; (2) intramural sports program; and (3) varsity sports program.

Some form of participation is required of all able-bodied freshmen not engaging in the intercollegiate program. A sports educative program is required in which participants are introduced into competitive activity. In this program stress is given to the development of skills in individual games and competition, such as tennis, squash, badminton, swimming, golf, and other sports which have high carry-over value to postgraduate life. Competition in group games, such as basketball, softball, and soccer is also provided. This program affords the opportunity for individuals to learn the basic fundamentals in a number of types of activity and to develop neuromuscular co-ordination necessary to accept other physical challenges.

Under traditional student leadership, but with the possibility of being able to call on a recently established Athletic Board for counsel when desired, the varsity sports program, in somewhat expanded form, continues to meet the needs and interests of students to whom intercollegiate competition makes an appeal.

For those men who are not interested in the intensity of intercollegiate athletics but who may, nevertheless, welcome opportunity to test their skills against other In-

(Continued on page 394)

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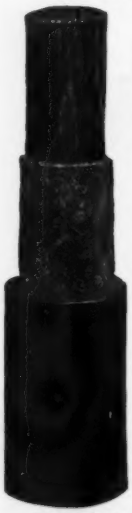

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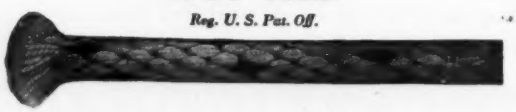


Our extra quality sash cord, distinguished at a glance by our trade-mark, the colored spots. Especially well known as the most durable material for hanging windows, for which use it has been specified by architects for more than half a century.

THE INSTITUTE GAZETTE

(*Continued from page 392*)

stitute groups, the intramural sports program has been expanded. In this category, opportunity is provided for systematically organized groups within the Institute to pit their skills against other groups, whether they be dormitory residents, commuters, or those dwelling in fraternity houses.

But whatever form of activity most interests the student, he is encouraged to participate, not for the heroics of high scores but for the contribution which he can make to his own well-being. In the Institute's athletic program "the play's the thing."

Encomium

RECENT modernization and expansion which permit the Department of Mechanical Engineering to handle increased student enrollment were particularly noted by the members of the Department's Visiting Committee * who met at the Institute on May 2, 1947. Members of the Committee inspected the space and facilities assigned to the Department and made a tour of the principal laboratories with the staff members in charge who explained their objectives and showed examples of current thesis work. Laboratories inspected included: Machine Design, Fluid Mechanics, Heat and Power, Heat Transmission, Plasticity, Testing Materials, Fatigue, Dynamics and Control, Stress Measurement, Machine Tool, Sloan Automotive, and Gas Turbine.

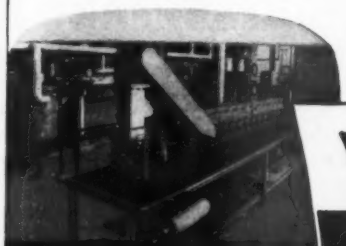
In the afternoon and again in the evening the Committee met with members of the Department and officers of the Institute for a discussion of specific questions of the Mechanical Engineering curriculum and its relation to the Departments of Aeronautical Engineering and Metallurgy. As a result of its own inspection and of the subsequent discussions, the Committee is gratified to report a high level of co-operation and teamwork in the execution of the post-war program to advance mechanical engineering science and to carry the training of students into the higher professional levels required by modern industry.

In its last report, the Committee pointed out an opportunity to unify the concepts involved in altering the shape of metals by the use of basic ideas both from mechanics and from metallurgy, and recommended that eventually work at the graduate level should be offered in mechanical processing. The Committee therefore heartily endorses the present approach to this problem in which a separate laboratory under the direction of Professor John Wulff has been established recently. The staff for the new laboratory is drawn from the Departments of Mechanical Engineering and Metallurgy and with the co-operation of these two Departments provides undergraduate instruction in metal processing

Undoubtedly the present grouping together of facilities for casting, forging, rolling, stamping, drawing, and weld-

* Members of this Committee for 1946–1947 were: B. Edwin Hutchinson, '09, chairman, Rear Admiral Luis de Florez, '11, Norman D. MacLeod, '14, Frederick S. Blackall, Jr., '22, William H. Collins, Kenneth H. Condit, and Ralph E. Flanders.

(*Continued on page 396*)

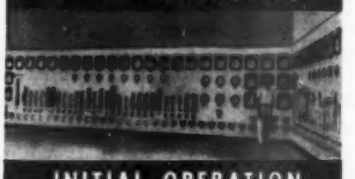

PILOT PLANT

PROCESS DESIGN

MECHANICAL DESIGN

SHOP FABRICATION

FIELD ERECTION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THE INSTITUTE GAZETTE

(*Continued from page 394*)

ing of metals, and for carrying out studies in powder metallurgy, and so on, is essentially sound. Nevertheless, the full potential in instruction in metal cutting cannot be realized so long as the Machine Tool Laboratory is not in close proximity to other metal-processing facilities. For this reason, the Committee renews its recommendations that all metalworking facilities be housed together.

It is understood that machine tools sufficient to modernize and expand the Machine Tool Laboratory have been obtained from war surplus stocks. It therefore remains to secure funds to provide adequate housing. Adequate housing for the basic manufacturing operations is considered essential to give the unity and prestige required to focus the attention of both students and employers on the application of engineering science to these ancient arts.

Considerable study was given to present methods of teaching machine design. The Committee concurs in the Department's desire to provide a design seminar room equipped with specialized reference publications and instructive examples of representative mechanisms illustrating the application of design principles. To a considerable extent, design involves an art that can be developed in the student only by practice with the aid of expert criticism, free discussion, and comparison.

The Committee was pleased with progress on the construction of the Gas Turbine Laboratory and with the addition to the Department's staff of William R. Hawthorne, '39, Associate Professor of Mechanical Engineering, and Ernest P. Neumann, '38, Assistant Professor of Mechanical Engineering, to supplement the special competence in this field of Professors C. Richard Soderberg, '20, Joseph H. Keenan, '22, and Ascher H. Shapiro, '28, Associate Professor of Mechanical Engineering. These men, together with colleagues in the Aeronautical Engineering, Chemical Engineering, and Metallurgy Departments, constitute an outstanding group of teachers.

The generosity of Alfred P. Sloan, Jr., '95, member of the M.I.T. Corporation, has enabled the Department to modernize and extend the facilities of the Sloan Automotive and Aircraft Engine Laboratory. The expanded laboratories are made possible at a time when urgently needed; they will accommodate double the number of students for whom facilities were previously provided.

Impressed by the serious concern with which the Department's staff members regarded the art of teaching, the Committee especially commends the program of monthly seminar meetings devoted to specific topics of teaching method. Increased enrollment, requiring the addition to the staff of young engineers without previous teaching experience, and the large proportion of veterans make it especially important to give attention to the effectiveness of the teaching offered by the Department. The Committee was interested to learn of the co-operation of the students in evaluating the teaching effectiveness of the staff and recommends that such co-operation be developed on a continuing basis. The Committee heartily endorses the proposal to revive the honors course for seniors who show superior aptitude for graduate work.

(*Continued on page 398*)

History-making power stations

OAK RIDGE! No need to cite pioneering achievements or record performance to call this power station *history-making*. As the source of most of the power required to produce the atom bomb, it shares the fame of the product.

But on its own, the Oak Ridge Power Station is a big story. Take its boilers, for example. There are three of them, each as high as a twelve-story building and each capable of producing more than three quarters of a million pounds of steam per hour at a pressure of 1400 pounds per square inch. At full capacity, they consume about three carloads of pulverized coal every hour. Their construction required the use of sixty-five hundred tons of steel, which included the equivalent of 200 miles of alloy and steel tubing. These boilers rank among the largest and most efficient in the world.

Such an installation normally requires more than two years for design, fabrication and erection. But under war conditions, where the impossible was done promptly and the miraculous took but little longer, Combustion Engineering designed, built and erected these boilers in one-half the normal time.

For this and other contributions to atomic bomb production, Combustion Engineering was one of the companies that was given the Seventh Biennial Award for Chemical Engineering Achievement.

The association of C-E with Oak Ridge and many other power stations that have made history speaks for itself. The experience, special skills and advanced engineering that have brought about this association are available to you, whether your steam requirements be large or small.

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Knowledge — *to solve today's, and tomorrow's, steam generating problems.*

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THE INSTITUTE GAZETTE

(*Continued from page 396*)

HKN Honors for Three

OUTSTANDING young electrical engineers of the United States were recognized by the presentation of awards by the Eta Kappa Nu Association in Pittsburgh, Pa., this winter, during the week of the winter general meeting of the American Institute of Electrical Engineers. Suspended during the war years because security regulations prevented divulging the work of many candidates, the present awards named one man for each of the years 1942 through 1947, together with honorable mention awards.

Two M.I.T. Alumni and one additional staff member were among those to receive honorable mention for "meritorious service in the interest of their fellow men." Those selected for this distinction are: David B. Smith, '33, Vice-president, Philco Corporation, Philadelphia, named for 1942; Albert C. Hall, '37, Associate Professor of Electrical Engineering, honored in 1946; and Jerome B. Wiesner, Associate Professor of Electrical Engineering, selected for 1947.

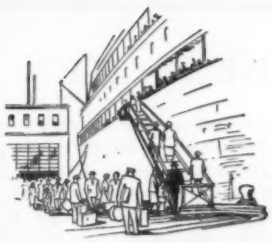
To qualify for the award, the candidate must be not older than 35 years nor be out of college for more than 10 years by May 1 of the year for which he is cited. After qualifying on these two counts the candidate is judged on the basis of accomplishment in technical, professional, and social fields. Final selection of candidates is made by a jury of awards composed of well-known engineers.

David B. Smith, Eta Kappa Nu recognition award honorable mention winner for 1942, received a bachelor of science degree in 1933 and a master of science degree in 1934 from M.I.T. and since his graduation has been affiliated with the Philco Corporation and its predecessors in Philadelphia. He began his association with that concern in the capacity of a patent engineer, subsequently rising in the next 11 years of service to the position which he now holds of vice-president in charge of engineering. He is also a director of the corporation and a member of its executive committee.

Albert C. Hall, recipient of honorable mention for 1946, received a bachelor of science degree from the Agricultural and Mechanical College of Texas in 1936. He then entered M.I.T. from which he received a master of science degree in 1938 and the degree of D.Sc. in 1943. He served a year as a laboratory instructor and then was made an instructor and assistant in charge of the Measurements Laboratory. From December, 1940, to June, 1943, he was an instructor and research engineer in developing automatic control equipment for defense applications. In July, 1943, Dr. Hall was promoted to an assistant professorship and became project engineer in the Servomechanisms Laboratory at M.I.T. In January, 1946, he was appointed director of the Dynamic Analysis and Control Laboratory.

Jerome B. Wiesner earned an Eta Kappa Nu honorable mention as an outstanding young electrical engineer for the year 1947. The University of Michigan conferred upon him a bachelor's degree in 1937 and a master of science degree in 1938.

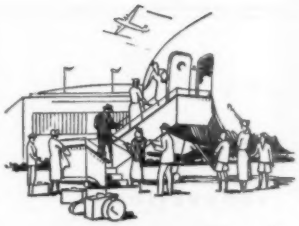
(*Continued on page 400*)



Neither darkness, fog or storm can hide icebergs, buoys, reefs and other above-water obstacles from the radar-eye of the *Electronic Navigator* developed by General Electric. Installed in the wheelhouses or chart-rooms of passenger liners, the navigator gives a radar map of the area surrounding the ship, and is capable of detecting obstacles up to 30 miles, depending on the size and shape of the object.

FOR GREATER SECURITY WHEN YOU TRAVEL

These G-E developments supplement safety devices on planes and ships



To the array of instruments safeguarding passengers on modern airliners, General Electric engineers have recently added another —the *Automatic Flight Recorder*. Riding in the plane's tail, the Recorder will note every variation in altitude and the plane's vertical acceleration. With these records, flight officials can check how closely a flight plan is followed, and in case of mishaps can secure information useful in eliminating causes of similar failures in the future.

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THE INSTITUTE GAZETTE

(*Continued from page 398*)

In 1940, the Library of Congress established a recording laboratory which because it was the first of its kind called for imaginative thinking as well as technical skill. One of Mr. Wiesner's special problems was the design and construction of apparatus for reproducing and preserving old wax cylinders and for reproducing badly damaged phonograph records.

In 1942 Mr. Wiesner joined the staff of the M.I.T. Radiation Laboratory and later became the project engineer for a major radar development as well as a member of the steering committee for the Laboratory. He is associate professor of electrical engineering and continues his research as assistant director of the Research Laboratory of Electronics.

M.I.T. Students Win Essay Prizes

TECHNOLOGY students won two of three prizes in the annual essay contest sponsored by the Old South Association of Boston recently. Highest award was made to Raymond V. Dyba, '50, and an essay on Washington's life by Owne P. R. Thomas, '50, was awarded a special prize. Both are students of Richard Prescott Harmon, an instructor in history at M.I.T. Mr. Harmon will receive $25.00 in books of his selection as a result of the good work of his students.

(*Concluded on page 402*)

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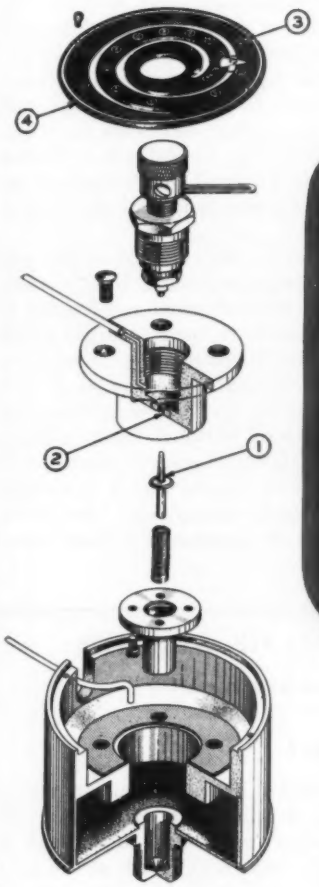

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1. Precision-machined tapered stainless steel plug
2. Tapered orifice
3. Actual reset rates — graduations divided by 20
4. Spiral scale permits nearly 2 full turns. Readings at smaller reset rates have greater spacings

Model 12610-20 Proportional-Reset Controller and Pneumatic Transmitter

Model 12610 Proportional-Reset Controller

Model 12610 Controller

Masoneilan proportional-reset level controllers have the entire reset mechanism *inside* the instrument case.

Reset is thus accessible, compact and protected.

The 12000 Series controllers with pneumatic reset are *package* units, complete and standard with the reset bellows and resistance unit integral, built-in. Masoneilan duplex level controllers and controller-transmitters also have this reset.

There are no external connections or adjustments to make. There is no external piping. And since the reset is an integral part of the controller and not an external appliance, the reset mechanism is always accurately calibrated, with graduations on a ten-inch scale proportional to actual reset rates.

When to Specify Reset . . .

1. When you want to get maximum vessel surge capacity at all times and in the presence of large and sustained load changes.
2. When smooth, uniform, controlled flows are essential to process operation.
3. When the level controller pneumatically sets the set point of a flow controller, or of several flow controllers in split-stream operation.

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THE INSTITUTE GAZETTE

(*Concluded from page 400*)

Corporation Elections

WILLIAM A. COOLIDGE, partner in the firm of Jackson and Curtis of Boston, and President of New Enterprises, Inc., and Beauchamp E. Smith, President of the S. Morgan Smith Company of York, Penn., have been elected Special Term Members of the Institute's Corporation.

Mr. Coolidge, a native of Boston and the son of Mr. and Mrs. Thomas A. Coolidge, was educated at St. Mark's School, Harvard University, and Oxford University. He has been affiliated with the firm of Jackson and Curtis since 1927 and has been a partner since 1930. From 1936 until the beginning of the war he was associated with the firm of Ropes, Gray, Best, Coolidge, and Rugg. He was engaged in civilian war work in Washington during World War II. Mr. Coolidge is a director of Wilson Jones Company, National Oil Products Company, National Research Corporation, and the Massachusetts Safety Council.

Mr. Smith, born in York in 1901, the son of Mr. and Mrs. Charles E. Smith, was graduated from Cornell University with a degree in mechanical engineering in 1923, and has been associated with the S. Morgan Smith Company continuously since his graduation. In addition to being president of his company, he is also a vice-president of the Commonwealth and Southern Company, and a director of the Western National Bank of York, the Brandt and Warner Manufacturing Company, the Southern Company, the Community Hotel Company, the Farmers' Fire Insurance Company, and other firms. He has long been active in the social and welfare organizations of York.

THE TREND OF AFFAIRS

(*Continued from page 370*)

Hot Nose, Cold Tail

HOT noses are accompanied by cooling tails in missiles flown at thousands of miles an hour at great altitudes. At least this is what calculations of Jackson R. Stalder and David Jukoff, research physicists at the Ames Aeronautical Laboratory, Moffett Field, Calif., indicate

(*Concluded on page 404*)

BIG GAME HUNTING

NORTHWESTERN WYOMING

Elk — Deer — Moose — Bear

Mountain Sheep

Early arrangements necessary. Moose and sheep licenses must be applied for before July 1st.

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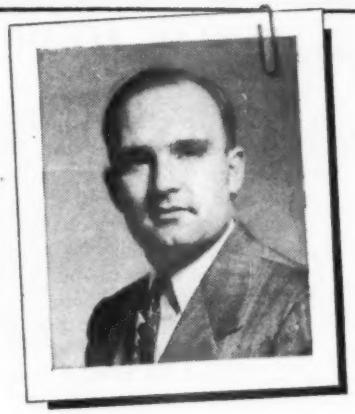

Robert E. Froom—Youngstown, Ohio

Another post-college career story

F

In 1940 I was studying to be a Civil Engineer at Ohio State University. In 1941 I was inducted, spent a good deal of time "paddling a saddle" in the Horse Cavalry, and then became an Aviation Cadet. After receiving my wings, I was assigned to the Air Transport Command, winding up my activities flying the "Hump."

Two days before V-J Day, I received a cablegram telling me of my father's death. Dad had been a New England Mutual policyholder so, shortly after returning home, I was introduced to the Company's representative in Youngstown, Harley Kirkpatrick. I soon realized that Mr. Kirkpatrick had been of invaluable service to my father and to the whole family. When he learned that I wanted to go into business for myself, he suggested life insurance, and arranged an interview with the General Agent in Cleveland, and with the Home Office in Boston.

Investigation convinced me that as an Agent for New England Mutual I would basically be in business for myself--with no real ceiling on my earnings, and complete independence of action. With everything to gain and nothing to lose, I took the Company's aptitude test, and qualified.

To date, I have completed a thorough training course in the Home Office in Boston; I have attended two Company conventions; I have my own office, and I have placed a half million dollars of insurance on the lives of people in my community. Each day I discover new uses for life insurance and realize that there's no limit to the amount that will be bought in the future.

I'm certainly glad I chose life insurance as a career. Besides the earning possibilities and the independence, it gives me the deep satisfaction of knowing that my services can be as valuable to my clients as were those of Mr. Kirkpatrick to my own family.

Graduates of our Home Office training courses, many of them new to the business, are selling at a rate which produces average first-year incomes of $3600. The total yearly income on such sales, with renewal commissions added, will average $5700. Facts such as these helped Bob Froom solve his career problem. For additional facts and figures, write: Mr. H. C. Chaney, Director of Agencies, New England Mutual Life Insurance Company, 501 Boylston Street, Boston 17, Mass.

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It's Sanforized, to keep shrinkage under 1%.

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THE TREND OF AFFAIRS

(*Concluded from page 402*)

according to a report delivered before a joint meeting of the American Physical Society and the Institute of Aeronautical Sciences.

Overheating of the nose of aircraft or missiles is one of the many new problems of designers in this supersonic era. In reporting calculations on missiles traveling as fast as 13,000 miles an hour, at altitudes of 75 to 150 miles, Dr. Stalder reported that as speeds are increased a point is reached at which the faster a missile is flown, the cooler the boat-tailed section becomes. The new information that tails become cooler as noses become hotter suggests the possibility of an internal cooling system.

M.I.T. REDEPLOYS FOR PEACE

(*Concluded from page 374*)

Zacharias, also of the Department of Physics and earlier from Hunter College and the Radiation Laboratory, accepted the directorship of the Laboratory for Nuclear Science and Engineering. Edward S. Taylor, '24, of the Department of Aeronautical Engineering was appointed director of the new Gas Turbine Laboratory. Eugene W. Boehne, '28, came from the General Electric Company to succeed Professor William H. Timbie, retired, in charge of the Co-operative Course in Electrical Engineering. Ivan A. Getting, '33, from Yale University and the Radiation Laboratory is now professor of electrical engineering; Bruno B. Rossi from Cornell University, Victor F. Weisskopf from the University of Rochester, and Albert G. Hill from M.I.T. and the Radiation Laboratory are professors of physics; Charles DuB. Coryell, from the University of California and the Clinton Laboratories at Oak Ridge, is professor of chemistry; Hsue-Shen Tsien, '36, from the California Institute of Technology, is professor of aerodynamics; Norman J. Padelford, from the Fletcher School of Law and Diplomacy, is professor of international relations; Douglass V. Brown is the first appointee to the new Alfred P. Sloan Professorship of Industrial Management; and Jacob P. Den Hartog, from Harvard University, is professor of mechanical engineering.

On the fiscal side, Joseph J. Snyder is now filling the long-vacant post of assistant treasurer and is giving special attention to increasing the Institute's capital resources. Robert M. Kimball, '33, who during the war organized and directed the Institute's first Personnel Office, joined the President's Office as assistant to the president and has helped to carry the increased responsibilities of the office.

These men, together with the colleagues they have joined, are the real measure of the Institute's success in rebuilding itself as an educational institution. They, together with the extraordinary student body now at M.I.T., are evidence enough that the impetus and the new spirit which President Compton brought to the Institute in 1930 still guide its redeployment for future widened service. Under his leadership there has been one clear objective: to maintain here in Cambridge such a combination of facilities, programs, and men that outstanding young scholars from all over the world will seek it out as did the wandering scholars of the ancient universities.

What are YOUR specifications for a business career for YOURSELF?

Check them off against the advantages of a career as a life underwriter of The Equitable Life Assurance Society

● The opportunity to become a representative of The Equitable Life Assurance Society of the United States as a life underwriter is open to a limited number of college men who can qualify. Training will be provided.

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Your income, right from the start, reflects the full value of your accomplishments. No seniorities, no delaying precedents hold you back. If you seek a managerial or executive position, you are helped by The Equitable's policy of filling such positions from within its own ranks.

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A Report

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TEXTILE REQUIREMENTS CONFLICT

(*Continued from page 380*)

tion. For example, to return to the jungle uniform in which the best solution had been a compromise between insect resistance and coolness, it might be asked: "Of what merit is an apparel fabric as a protection against the malarial mosquito?" Infection of American troops in the tropics was almost universal and hospitalization on the active front was avoided only by use of the suppressive drug, atabrine. In view of the wide prevalency of the disease and the effectiveness of medical research in devising means of checking it, a strong school of thought exists at present in the armed forces that the requirement for insect resistance could well be eliminated from this item, thus permitting the adoption of lighter weight materials which would be more porous, and therefore cooler for the wearer.

Circumvention is an effort to avoid the problem of providing opposing characteristics by an entirely new approach in which the conflict no longer exists. To illustrate the effective use of this technique, we return to the sleeping bag, filling material for which should be compressible to facilitate portage, yet of sufficient resistance to body pressures when in use to provide good thermal insulation. During the war a mixture of 40 per cent down and 60 per cent waterfowl feathers was considered eminently satisfactory for the purpose. However, experiments carried on to find a suitable substitute for this material because of wartime scarcities revealed that this combination was not the ultimate solution. Actually, it represented somewhat of a compromise, since it was of low-bulk density and high compressibility, yet could be fluffed into an open, loose state even after having been subjected to continuous compression. Since it was obviously impossible to find a single filling material which would incorporate the diametrically opposite characteristics which were desired, the Army developed an entirely new concept, calling for the use of an inflatable pad in conjunction with the sleeping-bag assembly. Filled with air, the pad furnished the necessary insulation for the under portion of the bag while the feathers and down provided warmth for the upper portion. Low bulk in portage is achieved by release of the air and the highly compressible nature of the feather-down mixture. This latter feature is of great military importance, since the fighting efficiency of the arctic soldier is seriously impaired by a pack load of excessive or even considerable weight.

(*Continued on page 407*)

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TEXTILE REQUIREMENTS CONFLICT

(*Continued from page 406*)

Toward the end of World War II a new approach was proposed in the rendering of cellulosic structures resistant to fungus growth. Whereas previous attempts had been directed toward destruction of the invading micro-organisms, military scientists set out to effect a modification of the cellulose molecule so that it was no longer receptive to fungus attack. Since the mildew growth was powerless to degrade the modified cellulose, the necessity for a fungicide, with its potentially harmful dermatological effects, is removed. Also, durability is achieved, for the solubility requirement is also eliminated in the new approach.

Finally, the synthesis technique is an effort to reach the ideal solution by the development of entirely new materials in which the two conflicting requirements are no longer at variance. The classic example of synthesis is the story of the glider tow rope. Use of wire ropes or hemp cables in place of airplane-glider pickup ropes resulted in overacceleration and shock to the plane and glider, as well as to their respective occupants. To absorb the initial shock and provide a smoother take-off, a material of high strength and immediate elasticity was required. It was necessary to reject rubber for this purpose in spite of its great inherent elasticity because of its immediate recovery or snapback effect. High immediate stretch and slow recoverability were conflicting properties in known natural materials, but a newly developed polymer called nylon, in which both characteristics were found to coexist, proved to be the happy solution to this problem. Here was an ideal synthesis, although in this case the original investigators had no intention of developing a superior tow rope for airplane gliders.

A synthesis of more immediate interest is the vapor permeable coatings which are being explored with Army support. Here the pertinent qualities of water (hydrostatic) resistance and water vapor permeability can be controlled accurately in experimental runs, and optimum values can be chosen for specific end uses.

Warmth without weight was recognized before the war as the ideal combination of characteristics for clothing to be worn in cold climates, and its attainment posed a complex problem in textile manufacture. In standard constructions, thickness, upon which insulating power is so dependent, is directly related to weight. Modifications in the weaving structure, such as in the case of pile fabrics, napping operations in which the yarn surfaces were scratched up to form a second fuzzy surface over the fabric plane, and use of various types of fibers, were among the steps taken to increase the thickness without producing a corresponding gain in fabric weight. Although such measures were effective in some degree they failed to reduce the clothing load of the individual camping in the arctic to an extent consistent with operational efficiency. To achieve the desired warmth-weight ratio, battings of fine synthetic fibers, fluffed and resin-impregnated to retain shape, were quilted between highly wind-resistant fabrics. Thus was developed the padded clothing so well received by troops stationed in extremely cold regions.

(*Concluded on page 408*)

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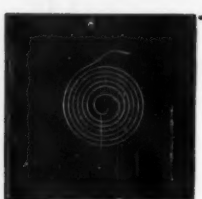
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TEXTILE REQUIREMENTS CONFLICT

(*Concluded from page 407*)

Review of these approaches throws some light on the balance of the textile research program undertaken by the armed forces. Compromise is a function of applied research and is reached after a planned investigation of the effect of the base material, the construction, and the finish. Elimination is achieved through uninhibited questioning of all military requirements by responsible analysts and by a constantly dubious attitude on the part of technologists striving to attain the required properties. Circumvention varies in its demand for applied *versus* fundamental research depending on the problem at hand. In this technique the problem may be avoided by application of an entirely different phenomenon without incurring the previous conflict. Where the scientist must develop basic facts about the properties of the substitute material or process, the problem becomes more fundamental than when he can use the results of the work of others. Synthesis represents head-on attack of the conflicting requirements which constitute the difficulty, with no thought of compromising or circumventing; it assumes that there is an ideal solution to the problem and seeks to uncover it by careful consideration of the fundamentals underlying each phenomenon involved.

Each problem requires separate consideration and there is no attempt on the part of Army research administrators to limit the balance of research under an arbitrarily established quota system. The challenge is directed to the individual project engineer, chemist, or physicist and it is his responsibility to exhaust each approach. We all stand to receive definite advantage from such research and the benefit received is on a common and personal basis rarely matched by other military studies. This point of view has been pungently expressed by one eminent physical chemist who said in considering the problem of wear resistance: "This interests me — it is as personal as the seat of my trousers!"

MAIL RETURNS

(*Continued from page 364*)

Unfortunately, railroad managements committed to the purchase and use of expensive Diesel power must go further and see that the Diesels are utilized regardless of cost. This quite frequently means that skilled personnel are diverted entirely from steam-locomotive servicing and all available man power is put to work to get the most out of the Diesels. Frequently, we hear that trains are actually held to make Diesels available.

While very little attempt has been made to do so, steam locomotives can be designed and built to outperform Diesels in many cases, and economically speaking, to equal the performance in the others. But to do this universally both the railroads and builders would have to adopt a program something like this: standardize power for certain services; design into steam-power units the advantages already known and which will materially improve performance; equip shops for expediting maintenance, similar to the Diesel shops; give steam power the same expert attention that now obtains for Diesels; have the best fuel available for steam engines, as is the present practice for Diesels; improve backshop techniques to reduce overhaul costs; train men to do jobs as correctly and efficiently on steam locomotives as on Diesels; make comparisons with only modern Diesels *versus* modern steam on an equal basis as to tonnage and other significant factors.

(*Concluded on page 410*)

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MAIL RETURNS

(Concluded from page 408)

Without waiting for the establishment of a comprehensive program for the future, however, it is quite possible to make substantial improvements in the operation of existing steam locomotives. Significant improvements might be expected from a program that would modernize engines by the addition of devices already available that will make for better performance, decreased maintenance, and lower operating costs; insist that steam locomotives operate with good coal; introduce maintenance and shop practices suggested above.

It is generally recognized that the nation's oil reserves are in danger of being exhausted in the not too distant future, whereas at the present rate of consumption the supply of coal will last for 3,000 years. This alone should be sufficient reason for railroad managements to concentrate on the development of coal-burning motive power now that Diesels threaten to fill the market.

At the present time, railroads are the only means of land transport which can economically burn coal as fuel. Consider the situation that might develop some years hence if the present program aimed at complete dieselization is continued; the nation would then be dependent partially on imported oil since it is unlikely that production of synthetic oil from coal will be adequate to meet normal demand. If, then, the United States became involved in another war, a decrease in the supply of imported oil, plus an increased demand, would create a fuel shortage for the military and a breakdown in national transportation.

Developments now going on in the combustion field with coal and devices will prove, in many instances, that steam can outperform Diesels on an equal basis. A steam locomotive, operated by the New York Central Railroad, equipped with poppet valves and a new type of stoker, ran as high as 29,000 miles per month in high-speed passenger service.

The Chesapeake and Ohio coal-burning steam turboelectric locomotives will have all of the tractive characteristics of a Diesel-electric. Speedwise and powerwise, steam locmotives now in operation can very easily keep up with today's modern pace. Not only does the steam locomotive have no stomach ulcers but its new stomach, in the form of all-welded boilers, will be even better than its old one. When the coal-burning locomotive is fed mud and rocks, it cannot digest them. When given good fuel, it is smokeless. Unfortunately for the steam locomotive, it has been able to digest a certain amount of mud, and because of this, it has been imposed upon and overdosed.

Statistics show that about 30,000 steam locomotives comprise the backbone of American railroad transportation, and as improvements now developed are applied there is every reason to believe that they will still retain their position until something requiring cheaper fuel than the Diesel comes into being.

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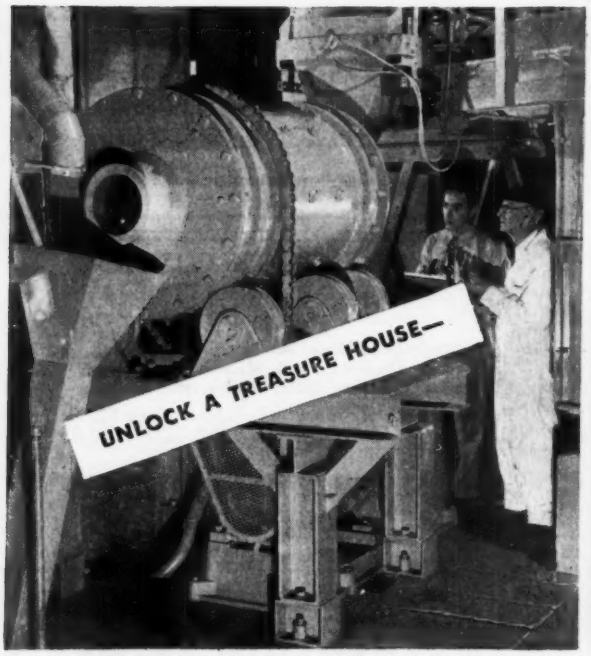

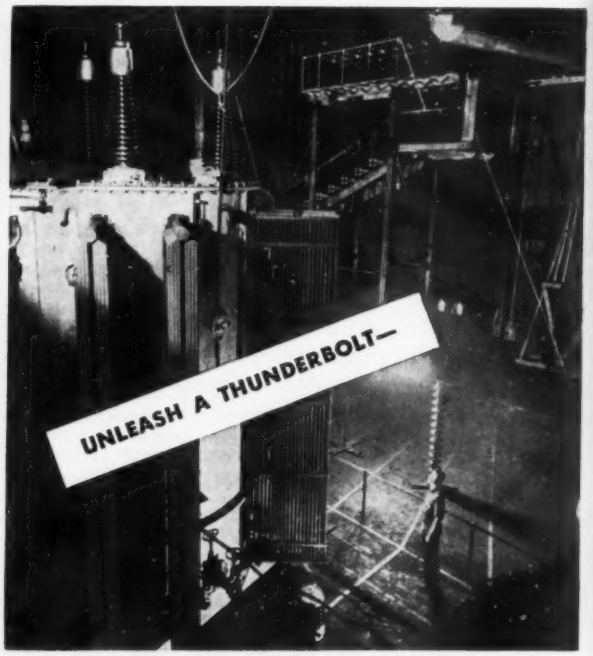

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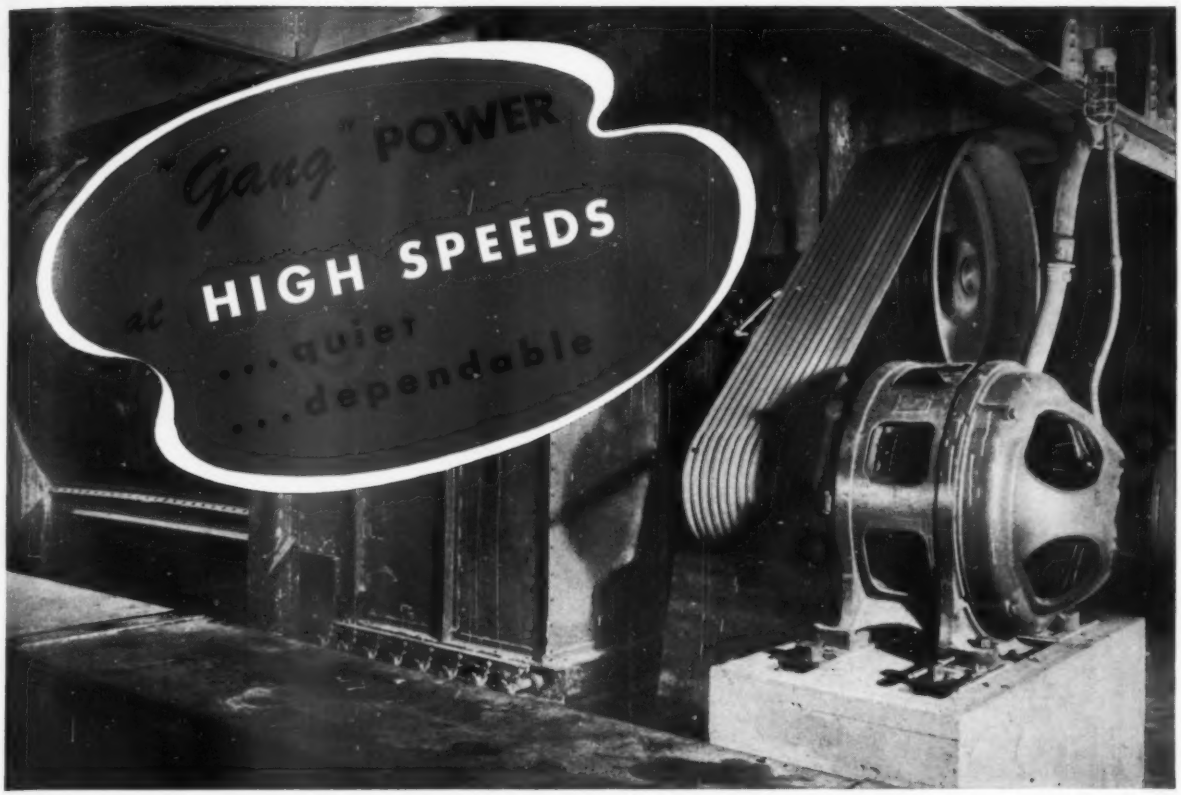

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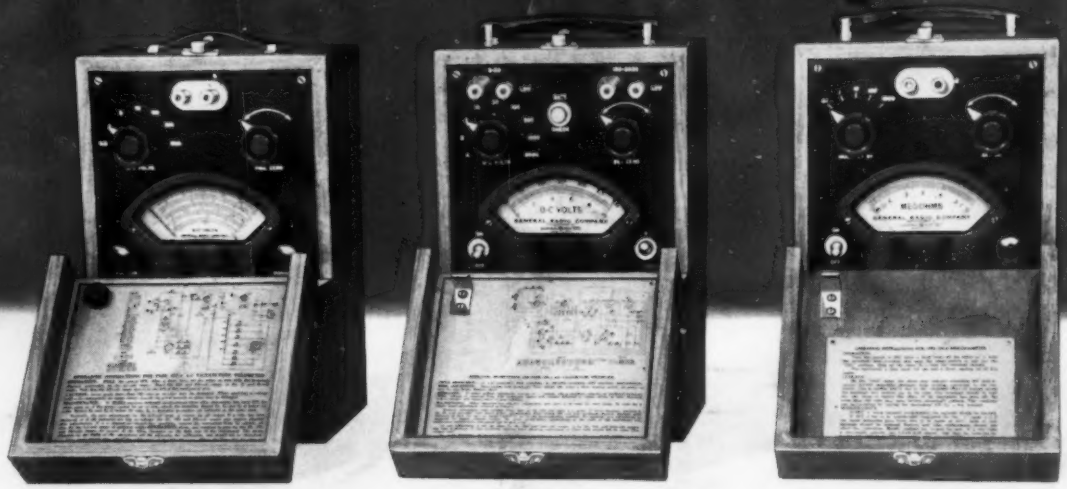

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WAVEFORM ERROR — On lowest ranges the instrument approximates a true square-law device. It is calibrated to read the r-m-s value of a sinusoidal voltage. On the higher voltage ranges it is essentially a peak-reading instrument calibrated to read 0.707 of the peak values and on distorted waveforms the percentage deviation from r-m-s values may be as large as the percentage of harmonics present.

FREQUENCY ERROR — Less than 1% between 20 cycles and 30 Mc. At 65 Mc the error is about +5% and at 100 Mc about +10%.

INPUT IMPEDANCE — The input capacitance is about 16 micromicrofarads. Parallel input resistance (at low frequencies) is about 5 megohms on the lower ranges and about 3 megohms on the upper.

PRICE: $180

TYPE 728-A
D-C VACUUM-TUBE VOLTMETER

This battery-operated v-t voltmeter is designed for measuring d-c voltages in low-power circuits where no appreciable power can be taken by the meter.

RANGE — 0.05 to 3000 volts in seven ranges (3, 10, 30, 100, 300, 1000, 3000 volts, full scale)

ACCURACY — Within ±3% of full scale on all ranges. If the full-scale sensitivity is checked occasionally the effect of aging, on the higher voltage ranges, can be eliminated

INPUT RESISTANCE — 1000 megohms on the ranges above 100 volts; greater than 5000 megohms on the lower

TERMINALS — Two sets of input terminals are provided; one for measurements at the 0 to 30 volts end of the range and the other for higher voltages

POLARITY — A reversing switch on the panel permits measurements with either the positive or the negative of the source grounded to the panel of the instrument.

EFFECT OF A-C — A superimposed a-c voltage of as high as 200 volts has negligible effect on meter indication

PRICE: $155

TYPE 729-A
MEGOHMMETER

This battery-operated megohmmeter is particularly useful where portability is required. It is well suited to field measurements of leakage resistance of cables and insulation.

RANGE — 2000 ohms to 50,000 megohms in five overlapping ranges

SCALE — Standard direct-reading ohmmeter calibration is used; center scale values are .1, 1, 10, 100 and 1000 megohms

ACCURACY — Within ±5% of the indicated value between 30,000 ohms and 3 megohms when the central decade of the scale is used; otherwise the error is increased because of the compressed scale

TEMPERATURE AND HUMIDITY — Effects of these are negligible over normal range of room conditions (65 to 95 deg. F.; 0 to 95% relative humidity)

VOLTAGE ON UNKNOWN — Voltage applied to the unknown does not exceed 22½ volts and varies with meter indication

PRICE: $105

THESE three accurate, highly stable and portable meters are all battery-operated and completely self-contained. They are housed in identical walnut cabinets 11 inches by 6⅝ inches by 5⅞ inches in size. Their accuracy is sufficient for a wide variety of measurements both in the laboratory and in the field.

Other G-R meters include a portable a-c operated vacuum-tube voltmeter for audio and radio frequency measurements up to several hundred megacycles, a crystal galvanometer direct-reading in voltage between 30 and 1,000 megacycles, an a-c operated megohmmeter with a range of 2,000 ohms to 50,000 megohms, a counting rate meter for measuring random emanations from radio-active materials, three models of output-power meters, and an audio-frequency microvolter with an output voltage range of 0.1 microvolt to 1 volt

G-R meters are carefully designed, correctly engineered, ruggedly constructed and accurately calibrated to insure many years of useful life.

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